A STUDY OF

# THE WORK OF THE LAND-GRANT COLLEGES IN THE TENNESSEE VALLEY AREA

IN COOPERATION

WITH

# THE TENNESSEE VALLEY AUTHORITY

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# A STUDY OF THE WORK OF THE LAND-GRANT COLLEGES OF THE TENNESSEE VALLEY AREA IN COOPERATION WITH THE TENNESSEE VALLEY AUTHORITY*

## A. INTRODUCTION

The Land-Grant Colleges of the Tennessee Valley States have been engaged upon the problems of agriculture for many years. Their efforts have been directed toward the training of leaders, the increase of agricultural and related knowledge, and the diffusion of accumulated information to the people of the region.

Five years ago a new agency, the Tennessee Valley Authority, was created by the Congress, to engage upon many problems, including some of those in agriculture, in the seven Valley States and adjacent territory. The States involved are Alabama, Georgia, Kentucky, Mississippi, North Carolina, Tennessee, and Virginia. The relations of the Land-Grant Colleges of those States, with the Authority, have been so intimate that their agricultural activities have constituted one coordinated and unified program of improvement.

A sufficient period of time has elapsed, since cooperation was begun, to justify taking account of stock. Accordingly, the Land-Grant Colleges have made an appraisal of (a) the development and programs of the Colleges, (b) regional conditions and problems, (c) the relations of the Colleges with the Authority, including mutual advantages in Federal-State cooperation, and the cooperative programs which have been developed, and (d) the results which have been obtained through the cooperative activities in experimentation and extension.

## B. THE STATE LAND-GRANT COLLEGES

The Congress of the United States has been sensitive to the needs of American agriculture, over a long period of years. This is proved by several consecutive actions taken, including the creation and financing of the U. S. Department of Agriculture and the Land-Grant Colleges of the several States.

### 1. STATE COLLEGES OF AGRICULTURE

More than 75 years ago, the Congress passed the first Morrill Act, in 1862, granting lands from the public domain to each State for the endowment of a college of agriculture and the mechanic arts. These colleges primarily were for the purpose of giving resident instruction in the branches of knowledge related to agriculture and the mechanic arts. In the southern States the found-

*The material in this publication is a slight revision of that contained in the mimeographed publication (84 pp.), with the same title, issued in October, 1938. Minor changes have been made in the text at several points. The principal revision is in the statistical data of Tables 2, 3, and 4 and in the accompanying text.

ing of these colleges was delayed until the Seventies by the conditions following the Civil War.

### 2. STATE AGRICULTURAL EXPERIMENT STATIONS

The Land-Grant Colleges soon discovered that but limited information on agriculture was available for teaching to students. The need for research and experimentation to discover additional facts was recognized. Some States provided for agricultural experiment stations as necessary adjuncts to their colleges of agriculture.

In 1887, the Congress acted on urgent representations from the States and passed the Hatch Act creating and aiding in financing an agricultural experiment station for each State. The $15,000 then made available annually to each Station was doubled by the Adams Act of 1906, and the resulting $30,000 was trebled by the Purnell Act of 1925.

It was the intent that these experiment stations should attempt to discover the facts urgently needed by the colleges in training agricultural leaders and in helping farmers to improve their practices.

### 3. FEDERAL-STATE AGRICULTURAL EXTENSION SERVICES

After the agricultural experiment stations had been at work discovering and publishing new agricultural knowledge for a quarter of a century, it became apparent that there was no adequate agency for carrying these facts to the men and women on the farms. Bulletins and circulars had been distributed, lectures given, and farmers' institutes and short courses held. Only the leading farmers were reached by these methods.

In 1904, the Federal Department of Agriculture began to establish a system of demonstration farms in the South. The purpose was to show the application of new methods and materials on farms, under actual conditions of practical operation. This was done in the belief that more farmers would become acquainted with farm demonstrations, and influenced by them, than had been reached by the earlier methods. As the idea spread through the counties and communities of the South, the results were so successful that the public became convinced of the value of this method of teaching. In the meantime, similar work had been started in the northern States.

The various States soon began to ask for a national agricultural extension system. Accordingly, in 1914, the Congress passed the Smith-Lever Act, providing for a cooperative Federal-State Agricultural Extension Service, under Federal supervision, and requiring that most of the Federal funds be matched, dollar for dollar, by the States, their counties, and local sources. Additional funds have been supplied in several supplementary Acts. The States and local agencies have contributed funds more than double the amounts required by the matching provision. The Service has proved its worth most fully, not only for the original

purposes, but also in helping to meet the much more extensive and complex agricultural problems arising from the World War of 1917-18, the agricultural depression of 1921, and the general depression of 1930.

#### 4. PROGRAMS OF THE LAND-GRANT COLLEGES

The Land-Grant Colleges of the seven Valley States had developed the best programs for agricultural betterment which their limited resources permitted. They were meeting the new demands for training, research, and extension in agricultural economics, home economics, agricultural engineering, chemical and other utilization of farm products, and land-use classification and erosion control to the best of their several abilities. Because of the large rural population, relatively low tax revenues, and the long-time accumulation of acute complex problems in proper land use, erosion prevention, living standards, tenantry, etc., they were greatly handicapped in their efforts to keep up with the new problems of the agricultural depression of 1921 and the general depression of 1930.

A brief description of the physical and economic features of the Tennessee River watershed is given below. It will serve as a background for understanding the problems of Valley-States agriculture and the cooperative activities of the Colleges and the Authority.

## C. THE TENNESSEE RIVER WATERSHED

The Tennessee Valley or, more properly, the Tennessee River Drainage Basin or Watershed, is an area of very diverse conditions in physical environment, in character and distribution of population, and in economic levels.

### 1. PHYSICAL CONDITIONS

Physical conditions include area, topography, soils, and climate, and the combined effects of all of these.

#### A. AREA, TOPOGRAPHY, AND SOILS

*Area.* The Tennessee River drainage basin or watershed contains larger or smaller portions of seven States, namely, Alabama, Georgia, Kentucky, Mississippi, North Carolina, Tennessee, and Virginia. It includes a little more than 41,000 square miles (some 26,380,000 acres), which is approximately the same area as that of any one of the component States. It contains all or parts of 124 counties, of which 64 are wholly within the Valley area.

*Topography.* The Valley area has a varied but mostly rough topography, ranging from wide alluvial valley through rolling hills of varying height, to steep mountain slopes. In elevation, it varies from about 300 feet above sea level, at the confluence of the Tennessee and Ohio Rivers, to mountain peaks towering 6,500 feet above the sea.

*Soils.* The soils of the area likewise are very diverse. They comprise some 118 series, divided into more than 500 types and phases or subtypes. Not only are the soil types numerous, but in the hilly and mountainous portions of the area the geologic tilting and folding have resulted in changes of soil types at short intervals on a single farm, sometimes in every hundred feet or so. These soils vary greatly in productiveness and also in erosiveness. Some are rich, some mid-quality, some poor. Some erode slowly, some erode moderately, and some rapidly, under the same treatment. In the course of a century or more of cultivation, many have been severely injured by long-continued erosion.

### B. CLIMATE

The climate of the area varies from the equivalent of that in central New York or northern Ohio to that of central Alabama.

*Temperature.* Winter temperatures vary from a minimum of -20° in the northeastern portions to 20° F. in the southern part. Summer temperatures are no less variable. The frost-free period varies from 150 days at high elevations in the northeastern mountains to 300 days in the southern lowlands.

*Precipitation.* The combined rainfall and snowfall varies from 40 to more than 80 inches of water annually in different sections, with an average of 50 inches. It is highest in the mountainous portions where slopes are steepest and danger of water damage greatest. In spite of the abundant total watering, severe droughts occur, as in the 83-day period of early 1936, when water supplies became seriously short and agricultural production was jeopardized. These conditions led to some provision for local irrigation in future drought periods.

### C. EROSION EFFECTS OF PHYSICAL CONDITIONS

Because of the several physical factors discussed, and because of some cultural factors yet to be described, erosion effects have become especially severe. Among the causative factors are the relatively steep slopes, the high annual precipitation, the lack of soil protection through freezing in winter, the long period elapsed since settlement, and the previous dominance of erosion-permitting row crops. These factors have combined to make the southern Appalachian plateau a badly eroded and eroding region. The Tennessee River watershed is fairly typical of the entire region in this respect. Increasing erosion not only has impoverished the local farmer but it has caused increasing silting of waterways and mounting flood damage to many other farmers, city dwellers, and industrial enterprises, oftentimes hundreds of miles downstream from the eroding farms.

## 2. POPULATION OF THE AREA

The total population of the Tennessee River watershed is approximately 2,500,000 persons. Of this number, about 77 per cent, or 1,925,000 persons, live in rural areas, either on farms or

in villages of less than 2,500 population. Of the total population, nearly 54 per cent, or 1,350,000 persons, actually live on farms.

The total population of the seven States containing the Tennessee River drainage area is approximately 18,388,000 persons, by the census of 1930. Of this grand total, about 70 per cent are rural dwellers, as defined above. Of this grand total, also, almost one-third live either in the watershed or in areas sufficiently contiguous to be directly influenced by activities within the watershed area. This region contains an unusually high proportion of American colonial stocks and a relatively small proportion of recent immigrants. It therefore is much more homogeneous in population than many sections of the country.

#### A. DENSITY OF POPULATION

A total population of some 2,500,000 in some 41,000 square miles equals an average density of about 61 persons per square mile. A rural population of 77 per cent, or 1,925,000 persons, gives an average density of 47 rural dwellers per square mile. With 54 per cent, or 1,350,000 persons, on farms, the average density of farm population per square mile in the watershed area is 33 persons. This is much higher than for the United States as a whole.

The actual densities are much higher than these. Of the total area of some 41,000 square miles, nearly one-third is in mountainous timbered areas, including several National Forests and part of one National Park. The remaining approximately 68 per cent, or 17,880 square miles, are in farms. On this basis, the average density is nearly 90 persons in total population, or 69 rural dwellers, or 48.5 farm dwellers per square mile of land in farms.

#### B. RURAL BIRTH RATE

The rural birth rate is higher than the urban, throughout the United States. With 77 per cent rural, and 54 per cent farm population, the area much more than maintains its population. In this area, moreover, the rural population has a considerably higher birth rate than that for the rural population of the country as a whole. The result is the high density of population per square mile, which constitutes a tremendous draft on the land resources of the area.

### 3. ECONOMIC AND SOCIAL CONDITIONS

The physical features and population densities, presented above, are partly responsible for certain economic and social conditions existing in the area. These may be discussed under land-use conditions, farming systems, depletion of natural resources, and low production and income levels.

#### A. LAND-USE CONDITIONS

The Tennessee River watershed comprises some 26,380,000 acres, of which about 68 per cent, or approximately 17,880,000 acres, are in farms. The wide diversity of soil, topography, and

climate causes wide differences in land use and farming systems. About one-half of the total farm area, or some 8,950,000 acres, is in farm woodland, pastured and unpastured. The remaining 8,900,000 acres are devoted to open pasture, meadow, and crops. The area supports some 255,000 farm families, with an average of five persons each. It provides about 44 acres of crop and pasture land per family, or 8.9 acres per person. The average size of all farms in Tennessee is 70 acres, and has been growing smaller for several decades.

### B. FARMING SYSTEMS

The types of farming vary greatly in the area. Certain districts follow livestock and grain production comparable to that of the Corn Belt. Other portions exhibit the intensive one-crop farming of the Cotton Belt. Tobacco, dairying, fruits, and truck crops assume major importance in certain localities. In much of the more mountainous area, the agriculture is of the self-contained, self-sufficient, or subsistence type, with corn in small acreage as the dominant crop. There are all gradations between these types.

These conditions result in part from the time of settlement and the character of the colonial settlers and in part from differences in soils and topography. At the time most of the area was settled, no extensive grants of land for personal services were being made. Most of the original settlers had been small farmers, laborers, or tradesmen in the Old World, and had no knowledge of the need for larger acreages in the new environment. They therefore acquired too little land for economic development and use.

### C. DEPLETION OF NATURAL RESOURCES

The major natural resources of any region are land, forest, water, minerals, and wild-life, including scenic beauty. The first effort of pioneer agriculture is to remove the forest cover. Lumber companies follow suit in the nonagricultural portions of an area. Fire follows both operations, destroying leaf mold, killing reproduction, and restricting cover and food supply for game. Destruction of cover reduces storage of water and natural discharge of water, permits erosion of the soil, causes destructive floods, and also exposes crops to the ill effects of seasonal drought. The already diminishing wild life is well-nigh exterminated in attempts to supplement the deficient food supply. Destruction of forest, curtailment of water bodies, and reduction of game resources, in their turn, reduce the opportunity to attract tourist and other supplementary revenues to an area.

### D. LOW PRODUCTION AND INCOME LEVELS

The inevitable result of uneconomic land holdings, excess population, and sometimes poor soil also, has been a relatively low production per acre and per capita. This has caused a relatively low standard of living for a considerable part of the population, both owners and tenants. Inability to provide adequate machinery, soil amendments, and fertilizers caused low production per acre. Small acreage resulting from small original holdings and increase

in population has kept production per capita low. The growing population also has forced farming farther and farther up the steeper and more rapidly eroding slopes.

The production of primary food and feed crops, both plant and animal, is not sufficient for the needs of the Tennessee River area. Cotton and tobacco are the principal surplus commercial crops. They do not produce sufficient cash income to balance the deficit caused by the necessary purchase of deficient food and feeds. Increasing acreages of the soil-depleting cash crops, grown in an attempt to overcome this cash deficit, have resulted in the more rapid deterioration of land resources through soil erosion and depletion of fertility. Until the eradication of the cattle tick in recent years, the development of a livestock industry was severely hampered.

From these bases has developed a condition of dietary deficiency, inadequate housing and equipment, meager transportation facilities, and lack of educational and health opportunities which has restricted the development and useful expression of fine native abilities, entailing loss to the whole country. Thus there has been a vicious circle of continuing deprivation, which has not yet been broken for a considerable part of the people of this area.

## D. RELATIONS WITH THE TENNESSEE VALLEY AUTHORITY

The Tennessee Valley Authority was created by an Act of Congress approved on May 18, 1933. The Act required the Authority to undertake certain activities in flood control and in the improvement of the quality of fertilizers and the cheapening of their cost to the land. To give practical effect to the statute, extensive activities in water control and land-use adjustment were required within the Tennessee River watershed in order to prevent the silting of reservoirs and consequent loss of large Authority investments in dams, reservoir areas, and electric generating plants.

It was evident that these agricultural requirements of the Act and the amendment would compel the Authority to undertake many activities which not only were of interest to the Land-Grant Colleges but actually lay within some of the fields they were occupying. For these reasons, the question of their relationships to the Authority in these activities became of acute interest. It was a matter of concern, not only to the individual agricultural colleges of the seven Valley States but to the Association of Land-Grant Colleges and Universities, as well.

### 1. ASSOCIATION RELATIONS WITH THE AUTHORITY

At the 47th Annual Convention of the Association, in 1933, Chairman Arthur E. Morgan of the Authority addressed the Association on the work of the Authority, giving a broad outline of its technical, economic, and social problems in the area. At the 49th Convention in 1935, Dr. Floyd W. Reeves, TVA Director

of Personnel, addressed the Subsection on Resident Teaching on "Cooperation of Land-Grant Colleges with the Educational Program of the Tennessee Valley Authority." He covered the classroom training of TVA employees at the dam sites and similar locations, the library service and project training of the reservoir-clearance crews, and the broader agricultural training in the use and conservation of land and water.

At the 47th Convention in 1933, there was much discussion of the work of the Authority and the relations of the Land-Grant Colleges to it. A committee was appointed to confer with the Authority "in regard to such features of its work as naturally fall within the field of work of institution members of this Association." Further discussion ensued at the meeting in 1934. At the Convention of 1935, the Executive Body invited Dr. Harcourt A. Morgan to discuss before it any matters of mutual interest. He described the methods by which the Authority worked through the seven Land-Grant Colleges of the Valley States, under a signed agreement which will be discussed later. Another Conference and Cooperating Committee was appointed by the Executive Body at this meeting, and reported later in the meeting. Its recommendations for cooperation with the Authority were referred to the Executive Committee of the Association.

At a meeting of the Executive Committee in January, 1936, Dr. H. A. Morgan and other TVA officials were invited to appear. Dr. Morgan outlined the general agricultural requirements of the TVA Act, and the relations of the Authority with the Land-Grant Colleges. It was voted that "the President and the Secretary of the Association be requested to explore the possibilities of utilizing the TVA agricultural functions for the wider benefit of agriculture, and to present to the Executive Committee at its next meeting a plan by which the Association of Land-Grant Colleges and Universities may take advantage of those opportunities."

At this meeting of the Executive Committee, the national phosphate situation was discussed and later a joint committee of the Association and the U. S. Department of Agriculture was appointed to study the problem. At the annual meeting in 1936, this Committee submitted a comprehensive report on "The Conservation and Use of our National Phosphate Resources for the Permanent Benefit of the American People." This was printed in the Proceedings and later mimeographed and widely distributed. Director Mooers, of the Tennessee Agricultural Experiment Station, was a member of the committee. Copies of the Joint-Committee Report have been widely distributed by the U. S. Department of Agriculture and the Tennessee Valley Authority and still may be obtained from them.

### 2. VALLEY STATES RELATIONS WITH THE AUTHORITY

On the creation of the Tennessee Valley Authority in 1933, it was immediately evident to the Land-Grant Colleges of the area that some of the objectives of the TVA were similar to certain activities of the colleges. Two conferences of representatives of

the Valley States Colleges and the TVA were held in 1933 and mutual problems discussed. Dr. H. A. Morgan of the Authority expressed the desire that the Authority's agricultural activities should be carried forward in cooperation with the Land-Grant Colleges of the States involved.

### A. RESOURCES OF THE LAND-GRANT COLLEGES

In proposing complete cooperation, the Authority recognized that the Colleges had definite responsibility for agricultural betterment in their several States and that they possessed many resources for this purpose. Among these resources were large staffs of highly trained and experienced specialists in administration, teaching, research, and extension; extensive equipment and facilities in the way of buildings, laboratories, libraries, experiment farms, machinery, etc.; large accumulations of experience and information on the difficult problems of the area; and, finally, the confidence and support of the people of their respective States.

Duplication of these resources on the part of the Authority was recognized to be not only wholly unnecessary but wasteful of the money of the people. The Authority and the Colleges recognized also that any attempt to carry through an agricultural program independently of the established State Land-Grant Colleges would lead almost inevitably to a confusion on the part of the farmers and other citizens of the several States. In the third place, the program could not have been inaugurated as promptly or conducted as effectively at the start by a new agency as by one long established and fully organized.

### B. THE COORDINATING COMMITTEE

At a third conference, held in July, 1934, significant action was taken. Each of the seven Valley States Colleges was asked to select one man to represent the college in all agricultural planning activities. A Coordinating Committee of three persons, one representing the Valley States Colleges of Agriculture, one the various Federal agencies concerned, and one the Tennessee Valley Authority, was created. Its function was to coordinate the activities of all these groups of agencies and to work out organization and plans for all agricultural adjustment activities in the area.

On the coordinating committee, Dean Thomas P. Cooper, of the Kentucky College of Agriculture, was elected to represent the States; Director J. C. McAmis, of the Department of Agricultural Relations of the TVA, was elected to represent the Authority; and Dr. C. W. Warburton, Director of Extension Work, in the U. S. Department of Agriculture, was elected to represent the interested Federal agencies in Washington. Dean Cooper was chosen to be Chairman of the Committee.

### C. THE 3-WAY COOPERATIVE AGREEMENT

In the early autumn of 1934, the Coordinating Committee prepared a Memorandum of Understanding to serve as the basis for

cooperative activities of the Valley States Land-Grant Colleges, the TVA, and the U. S. Department of Agriculture, in the seven Valley States. During the winter of 1934-35, this 3-way cooperative agreement was signed by the presidents of the seven Valley States Land-Grant Universities or Colleges of Agriculture, the Chairman of the Board of Directors of the Tennessee Valley Authority, and the Secretary of the U. S. Department of Agriculture. On May 1, 1935, a full-time executive secretary for the Coordinating Committee was obtained.

### 3. MUTUAL ADVANTAGES IN COOPERATION

Several advantages are recognized when two or more agencies conduct enterprises cooperatively. Among these advantages are the pooling of knowledge, facilities, and personnel; the development of a single coordinated program; the saving of money and time; and the more complete encouragement of democratic processes among the people in the area affected.

#### A. POOLING OF KNOWLEDGE AND FACILITIES

The available knowledge of any one subject or problem does not reside in any one person or group of persons. When two or more agencies must attack a common problem, the combined knowledge of all is greater than that of any one agency. If pooled, it becomes immediately available to all participants and thus enables a more effective planning of the program.

The same facts are true of physical facilities. Most established agencies have laboratories and other facilities and equipment in excess of their year-round requirements. They may lack funds to employ sufficient personnel to utilize completely the facilities possessed. In such cases a new agency, or one newly concerned with the problem, may make use of these incompletely-utilized existing facilities. Instead of providing duplicating facilities, they may furnish the personnel necessary to utilize sufficiently the facilities and equipment of other agencies.

#### B. A SINGLE COORDINATED PROGRAM

When two or more agencies attack a problem independently in the same area, two or more separate programs may develop. If competition or rivalry occurs, there is a constant temptation to justify the existing program rather than to discover the best procedures. This may result in lowered efficiency, lost time, ill-spent moneys, and delayed results.

These things are harmful in themselves. If the achieving of results is delayed by separate programs, or if the acceptance of the most desirable procedure is hampered by the spirit of rivalry or professional jealousy, there is loss not only to the agencies but to the constituencies which they serve. If the problem is a critical one, this last-named effect may be highly important.

#### C. SAVING OF MONEY AND TIME

Certain savings of money and time usually result from a cooperative attack on a common problem. These savings are in addi-

tion to the time saved through the pooling of the knowledge of plans and procedures at the start.

Money is saved through avoiding the necessity for purchase or construction of buildings and equipment by a new agency. It is saved also through the employment of only one group of employees instead of two or three, although the joint personnel usually will be larger than would that of any one of the competing agencies. The larger single personnel also will accomplish greater results. Money is saved also because there is no unnecessary duplication of work when the agencies cooperate. Anything which saves time also saves money.

Time in achieving results may be saved through better joint planning at the start. It almost certainly will be saved later because useful facts developed by any one worker or agency will be made available immediately to all cooperating workers or agencies. Time may be saved also because more work may be done in a single season or other time period with the joint facilities of all agencies than by the same facilities if the agencies are working separately.

#### D. ENCOURAGEMENT OF DEMOCRATIC PROCESSES

Cooperation itself is a democratic process. When two or more agencies of the highest levels of government, namely State and Federal, conduct their enterprises cooperatively, it sets a good example in effective citizenship. As such democratic methods of procedure become known among citizens, they are stimulated to adopt such beneficial procedures in other activities.

When the cooperative activities enlist the active and continued participation of thousands of farmers, the encouragement given to more democratic processes is immensely increased. This is true in the most extensive cooperative activities of the Land-Grant Colleges and the TVA in the Tennessee River watershed. The ultimate effects on good citizenship may be far reaching.

### 4. COOPERATIVE PROGRAMS DEVELOPED

Cooperative relations between the Authority and the land-grant institutions of the seven Valley States have been developed in many different fields. These may be divided into two major groups, namely, (a) research and experimentation, and (b) education and test-demonstration. Some activities, such as test-demonstration and terracing operations, relate to both groups. They primarily are education-demonstration, however, and are presented in the second group, with the exception of terracing-cost studies.

The different fields of activity, and the general procedures followed, are discussed below. The summarized results of each activity are presented in Section E of this statement.

The cooperative relations of each of the seven Land-Grant Colleges with the Authority are governed by the terms of a "master contract." A signed project contract covers each of the different activities conducted thereunder.

### A. IN RESEARCH AND EXPERIMENTATION

The agency of the College most frequently engaged in these cooperations has been the Agricultural Experiment Station. Whenever any other unit of the University or College has had part, it will be named at the appropriate point.

#### (1) ADVISORY RELATIONS ON FERTILIZER PROGRAM

Representatives of the Land-Grant Colleges, the U. S. Department of Agriculture, and the farmer organizations were asked by the Authority to advise it as to what fertilizer studies were most important. Under the Act of Congress, the Authority is required to undertake to improve the quality of fertilizers and to cheapen their cost to the land. The colleges and other representatives advanced the opinion that phosphorus was the most important limiting mineral element in crop and livestock nutrition. Accordingly, the Authority has given major attention to developing improved methods of manufacture and more highly concentrated forms of phosphatic fertilizers. It has been noted above that the Land-Grant College Association helped form a Federal-State Committee to investigate and report upon our national phosphate resources.

#### (2) RESEARCH IN PHOSPHATES

Extensive and critical laboratory research is basic to improvement in forms of phosphatic fertilizer or in methods of manufacture. When the Authority began operations, the Agricultural Experiment Station of the University of Tennessee long had possessed a well-equipped research laboratory and one of the outstanding leaders of research in this field. A cooperative program of investigation therefore was agreed upon by the Authority and the Tennessee Station, and has been continued. It covered the chemical composition and physical characteristics of the new materials developed, and also their compatibility with limestone, dolomite, slags, and similar soil amendments. Many of the results obtained have been published in a series of technical papers appearing in chemical and engineering journals, as discussed in Section E hereafter.

By a further cooperative arrangement, the Chief Chemical Engineer of the Authority is given office space in Ferris Hall, the Engineering Department building of the University of Tennessee. These arrangements have been mutually advantageous to the agencies concerned.

#### (3) STATION EXPERIMENTS ON PHOSPHATE EFFICIENCY

Any new fertilizer substance must be widely tested on many crops, under varied conditions of soil, climate, and farming systems. The Act creating the Tennessee Valley Authority provided that it might cooperate with national, State, and local experiment stations in tests of the use of new forms of fertilizers or of fertilizer practices, during the experimental period of their introduction. Under this proviso, the Authority has entered into cooperative agreements with the Agricultural Experiment Stations of the seven Valley-States Land-Grant Colleges. It is understood

that similar agreements have been made with the State Experiment Stations in most of the other States in the country.

These station experiments have had three main purposes. First, they determine whether a new form of fertilizer is harmful in any way. Next, they ascertain if the new forms of phosphates are as effective, per unit of phosphorus, as standard phosphatic fertilizers. In the third place, they discover the relative efficiency of each, and its effectiveness in comparison with standard forms, on a wide range of crops. The same facts are ascertained for each of the by-product materials developed by the Authority.

These data are obtained successively from experiments in greenhouse pots, from field cylinders (rims), and from station and substation plots and fields, and sometimes from outlying fields, situated on private farms on different soil types but controlled by the Station. In addition to immediate results, measurements are made of the residual effects on crops which follow in the rotation.

Among the phosphatic fertilizers which have been placed under experiment are TVA triple superphosphate, calcium metaphosphate, monocalcium phosphate, dicalcium phosphate, calcined rock phosphate, and fused rock phosphate. Special forms of phosphorus furnished for particular types of experimentation include fluorine-low or fluorine-free dicalcium phosphate for use in studies of animal or human nutrition, and liquid phosphoric acid for use in making special silages. Among the by-products widely tested have been calcium-silicate slag, both granular and ground, for liming purposes.

These materials are furnished by the Authority to the Valley-States Stations without charge for the materials, and the transportation charges usually are paid by the Authority. In this way, the stations are enabled to make extensive tests of various new products and to advise the Authority as to their efficiency under different conditions. The results obtained are summarized in Section E of this study.

Two rapid methods of determining the needs of different soils for phosphates, and the availability of the new phosphatic fertilizers to crops, have been studied cooperatively. One is an agronomic method, employing the 17-day growth of rye in the laboratory. The other is a botanic method, utilizing the growth of particular fungus species, especially of *Cunninghamella.*

All forms of animal life, including domestic animals and game animals, require adequate supplies of phosphorus for their development and functioning. Phosphatic fertilizers therefore supply the needs of both plants and animals. The increase in the phosphorus content of the herbage and grain of field, meadow, and pasture crops, caused by phosphatic fertilizers, is important. Some studies in this field are being made.

The nearly fluorine-free dicalcium phosphate developed by the Authority is being tested for animal feeding by the Tennessee Station. Adding phosphatic supplements to the feeding rations of domestic animals is a commercial practice.

The addition of acids or acid-forming substances in the making of silage from legumes and some other plants has been found necessary to the production of a nutritious and palatable product. The use of phosphoric acid in silage, not only to produce a good quality but also to increase the phosphorus content of the product, and thereby increase its feeding value, is under experiment by Valley-States Stations, in cooperation with the Authority.

### (4) SOIL SURVEY AND CLASSIFICATION

An accurate knowledge of the soil is absolutely fundamental to all programs for agricultural improvement. This knowledge must include soil type, slope, and conditions of erosion, stoniness, and plant-food content. Only thus may the value and best use of an area or a farm be determined. Such information therefore is basic to land-use adjustment, crop-acreage shift, soil conservation, soil fertilization and amendment, land purchase and sale, exercise of the right of eminent domain, water conservation, flood control, resettlement and rehabilitation, sound agricultural financing, location of new agricultural industries, highway location and road construction, promotion of cooperative programs, and the planning of power development for rural electrification.

Soil surveys have been in progress for more than 35 years. Methods have been so improved, however, that surveys completed more than 20 years ago are done over as time and money permit. The work is being done on a national basis, the State Agricultural Experiment Stations or other State agencies cooperating with the Soil Survey Division of the Bureau of Chemistry and Soils in the U. S. Department of Agriculture. The Federal and State agencies share more or less equally in supplying men and money, while the Federal Division makes the final maps, and publishes the cooperative results.

The necessity for effective land-use adjustment for water control and soil holding within the Tennessee River watershed led the Tennessee Valley Authority to enter into cooperative agreements with the seven Valley-States to speed up the surveys in the area, the Authority furnishing financial assistance for the purpose. The work is done with the State Experiment Stations in six States, the survey of Valley counties in Alabama having been completed previous to this agreement. The results obtained to date are summarized in Section E.

### (5) STUDIES OF WATER RUNOFF AND SOIL MOVEMENT

Facts regarding runoff of precipitation water and erosion of soil thereby, for different soil types, and from different slopes, are fundamental to effective water-control measures. Such information is largely lacking for the States of the Tennessee River watershed, where erosion processes and flood damage are very disastrous. Some studies to these ends are in progress cooperatively in laboratory, plots, and field. The cooperative procedures for actual water and soil control through producing better vegetative cover by improved fertilization of the soil, and through shifts of erosion-permitting row crops from eroding slopes to

more level land, are presented later under education and demonstration.

Runoff, erosion, and sedimentation studies have been established by the Virginia and Tennessee Experiment Stations, in cooperation with the TVA. Virginia, in 1936, established experiments on station plots and also on small watersheds on two important soil types in the mountainous pasture areas of southwestern Virginia, with several different degrees of slope on each type. Different fertilizer treatments are given to the different plots, all of which are grazed. The runoff water and its contained soil are measured. The Tennessee studies were established in 1937 on plots on the Experiment Station at Knoxville and the Tobacco Substation at Greenville, with mechanical equipment installed to collect representative samples of the soil and water lost. The plots at both Stations are on 10-percent slopes, with different cropping treatments.

The Alabama Station began another cooperative project in 1936. After preliminary investigations, two tilting plots, each 15 by 50 feet in size, were constructed on a mechanical framework which permits them to be tilted to any desired degree of slope up to 30 per cent. Artificial rainfall is applied from an overhead irrigation system, thus permitting rainfall intensity to be varied at will. Different types of soil from the Valley Area are placed in the tilting plots at successive periods. Runoff, soil movement, and soil loss are measured, after different intensities of precipitation on different degrees of slope. At present the important Decatur clay loam is being studied.

### (6) TERRACING COSTS

Mechanical structures, such as terraces and side-hill ridges, are recognized as useful supplements to the vegetative cover in preventing losses of water and soil. In this cooperative program of the Colleges, the Authority, and the farmers, these structures are being applied to large areas of farm land in the Valley States, as practical aids to better watershed protection through supplementing land-use adjustments and improved fertilizer treatments. The cost of these mechanical methods of protection in comparison with cropping methods, and of one such method in comparison with another, is a matter of much immediate importance to farmers. Accordingly, the Alabama Station, in 1935, began a study of terracing practices and an analysis of the factors of cost involved in their use. Data were collected on the cost of many different terracing operations, and covered both ordinary farm equipment and heavy power outfits, either cooperatively owned or leased.

### (7) FARM-MANAGEMENT INVESTIGATIONS

Studies in farm management and rural economics are necessary in order to determine the efficiency of each of the several crop and/or livestock enterprises of each farm, the efficiency of the entire farm as a business unit, and the community value of the type of farming followed. The cooperative program of the

Valley-States Land-Grant Colleges, the farmers, and the TVA for the readjustment of land uses to prevent erosion is a demonstration activity and will be discussed later. The change in type of farming, however, which results from these crop adjustments to include more grasses and legumes and better fertilizer practices, is a farm-management problem.

It is highly desirable that the efficiency of these readjusted cropping systems and practices be studied extensively but other pressing problems have caused such drafts on Station time and finances that little new investigation can be undertaken in this field. The Virginia Station, however, set up a study of the beef-cattle enterprise in Russell County, in 1935, to cover the factors affecting the carrying capacity of pastures and the readjustments possible to prevent erosion, maintain fertility, and increase income.

#### (8) PROCESSING AND MARKETING FARM PRODUCTS

There is pressing need to increase farm income by improving the quality of farm products, and therefore their marketability. Land-use adjustment in progress under the nation-wide program of the Agricultural Adjustment Administration, and the more intensive regional program of soil and water holding in the Tennessee River watershed, have made these questions even more vital in this area. Several projects in these fields have been developed by Valley-States Stations in cooperation with the Department of Agricultural Industries of the TVA.

The cooperative investigations of farm products have covered methods of curing hay and tobacco and storing sweet potato, better processing of sorghum sirup, quick freezing of fruits and vegetables and also their marketing, rapid methods of processing and spinning flax fiber, and processing of cottonseed.

#### (9) NEW OR IMPROVED EQUIPMENT

The development of new or better adapted forms of farm machinery and equipment sometimes is necessary to permit efficient farm handling of new crops, especially water-holding crops, on small farms. Without such implements the introduction of a new and desirable crop or practice often is seriously handicapped. The development of refrigerated storage units suited to the needs of small rural cooperatives serves not only to improve the dietary of the families but also to decrease the cash outlay for foodstuffs and to increase the income from home-grown food products.

Some of these projects have involved the cooperation of the Engineering Experiment Stations or Departments of Engineering in the Land-Grant Colleges and Universities, as well as that of the Agricultural Experiment Stations, with the TVA. The summarized results from all processing and equipment projects are presented in Section E.

### B. IN EDUCATION AND TEST-DEMONSTRATION

Since the creation of the Federal-State Agricultural Extension Service, effective in 1914, the Land-Grant Colleges have been vigorously promoting agricultural education on the farms and in

the farm homes through numerous demonstrations. Increasingly they have endeavored to make this a truly democratic process by encouraging the active leadership of the farm families, both in the planning and in the carrying out of the programs.

Among the important objectives of the Land-Grant Colleges in the Tennessee River area has been the diversification of crops, and especially the growing of more grasses and legumes in order to provide for better land use, better conservation of water and control of destructive soil erosion, and more dairy and livestock products for home consumption.

The creation of the Tennessee Valley Authority, and the development of its objectives, have given a great impetus to this extension movement. One of the objectives of the Authority, it will be remembered, is the improvement of the quality of fertilizers and the cheapening of their cost to the land. Another objective is the control of water and soil movement within the Tennessee River watershed, through the use of fertilizers or otherwise, in order to prevent the silting of Authority reservoirs and the consequent loss of investment in dams, reservoir areas, and electric power plants.

In connection with the development of new forms of fertilizer, the Authority was authorized to cooperate with National, State, and local experiment stations and demonstration farms in having these fertilizers widely tested during the experimental period of their introduction. The Authority was authorized further to make its fertilizer products available through the agency of the agricultural colleges and their county extension agents, for experimentation, education, and introduction of their use, in cooperation with practical farmers, so as to obtain information on their effect, value, and best method of use. Finally they were authorized to arrange with farmers and farm organizations for large-scale, practical use of new forms of fertilizer under conditions permitting an accurate measure of the economic return they produce.

The Land-Grant Colleges, through their Agricultural Extension Services, have been working with large numbers of farmers and associations of farmers in these and similar activities. It was a statesman-like movement, therefore, that the Tennessee Valley Authority should prefer to achieve its combined objective of fertilizer testing and water control through cooperation with the Land-Grant Colleges under formal contracts or memorandums of cooperative agreement.

Obviously, the first step in determining the effect, value, and best method of use of a new fertilizer on farms of practical farmers is to apply it to crop land and determine the effects produced by a comparison with comparable untreated areas. The recognized best method of erosion control is by improved vegetative cover, which not only prevents erosion of the soil, but also builds the soil in productivity and conserves water for the benefit of crops and the lessening of floods.

The two programs of fertilizer testing and water control have been united under these cooperative agreements by applying phosphate and lime to grass and legume crops which hold and improve the soil and conserve water. This cooperative program has been conducted in the Valley States in two somewhat different types of test demonstrations. The first type is called the farm-unit test demonstration, and the second is known as the area test demonstration.

### (1) FARM-UNIT TEST-DEMONSTRATION FARMS

In the testing of new and improved fertilizer, the act creating the Authority authorized arrangements with farmers and farm organizations for large-scale practical use of new forms of fertilizers under conditions which permit an accurate measure of the economic returns they produce. Obviously in measuring economic returns it is necessary to consider the entire farm, including the farm home, as an operating unit. It is not enough to discover the value and effect on individual fields or crops. Measuring economic returns requires ascertaining any improvement, both immediate and ultimate, in the yields and quality of crops, any increase in the carrying capacity for livestock, the increase in numbers and quality of farm animals, improvement in farm equipment and in the farm home, and any change in the living standards of the family. Such a program includes both experimentation and demonstration and hence has led to designating the farms where these tests are made as test-demonstration farms.

The essential steps in the procedure of establishing a farm-unit test-demonstration farm are as follows:

1. Appraisal of the agricultural situation in the community by the farm people, out of their own experience, at a meeting called by the county agent.
2. Analysis of the important problems affecting the local and larger situation.
3. Development of a program of adjustment designed to improve the local situation through attack on the problems analyzed.
4. Selection by a committee of farmers of an individual farm in the community, typical as to size, character of soil, type of farming, etc., on which the adjusted program is tested.
5. Obtaining the materials needed to carry out the program on this farm.
6. Applying the program on the selected test-demonstration farm and keeping careful records of the results to guide future practices in the community.
7. Holding meetings of the community group on the farm from time to time to note results and discuss their application.

The owner of the farm, with the aid of the county and community committees of farmers and the county agent, maps the soils and fields on the farm, inventories its facilities and equip-

ment, and determines the changes necessary to conform to the program which has been evolved. The test-demonstration farmer then agrees with his community committee and the State College to carry out this program for a period of at least five years, to keep the necessary records, and to report the results. With certain exceptions, he bears all the increased cost of changes in farm fencing and the purchase of any additional equipment and material needed. He assumes the financial risk involved by shifts in crops and livestock and fertilizer practices. He does this as a service to his community.

The program of test demonstration, necessary to the objectives of the Authority, fitted completely into the normal extension programs of the Valley States. The furnishing of quantities of concentrated phosphates and other assistance by the Authority for these purposes enabled the States to undertake a much more extensive and effective program than previously had been possible.

These farm-unit test demonstrations have been established most extensively in some 122 of the counties lying wholly or mostly within the Tennessee River watershed in these seven States. Less numerous test-demonstration farms have been established in many of the remaining non-Valley counties of most of these States.

The essential feature of these test demonstrations is that they are planned, organized, conducted, and, to a large extent, financed by the farmers in the community. The Extension Service aids in providing information and some leadership in setting up the organization and supervising the record-keeping, and the Tennessee Valley Authority makes a contribution of materials, and of funds for assistance in organizing and supervising the program. Because of the large part taken in the enterprise by the farmers, they are keenly interested in the progress of the demonstrations. This interest is evidenced by the large number of farmers who attend meetings on these test-demonstration farms, in some cases every farm in the community being represented. Farmers feel that they have a part in planning the program, and, as the demonstration is conducted under conditions similar to their own, they recognize that the results are dependable and readily adapt them to their own use.

Because this program increases soil-holding, soil-building, and water-conserving crops, and because it offers an opportunity for extensive testing of the new fertilizer products, the Authority furnishes sufficient quantities of its concentrated experimental phosphates to promote effective plant growth. This is not a distribution of free fertilizer in any sense. On the contrary, the participating test-demonstration farmers not only pay the freight and handling charges, but they also perform extra farm and clerical labor, often meet some additional expense, and likewise run some temporary financial risk in the process of land-use adjustment.

Up to the close of June 30, 1938, these community farm-unit test demonstrations had been established on 6,348 farms in 122

counties of the Tennessee Valley area. These farms had a total acreage of 1,094,719 acres. In 205 counties outside the Valley area in the seven Tennessee Valley States, there were 3,483 more of these farms, totaling 808,432 acres. The statistics for these and for the area test demonstrations are given more fully below, under "Scope of All Test-Demonstration Farms."

(2) AREA TEST-DEMONSTRATION FARMS

Test demonstrations on areas or small watersheds, as the name implies, are enterprises designed to enlist the active participation of all the farmers of a community or small watershed. In the farm-unit-test-demonstration program one such farm is selected in each community, an intensive 5-year adjusted farm management program is set up, and the community farmers study results from time to time and adapt them on their own farms as fast as they are able. In the area or small watershed test-demonstration program, on the other hand, the program is more extensive, and all of the farmers of the area or watershed are urged to begin participation in the program at the start. The procedures include readjustment of crops to conserve water and control erosion, as well as to build the fertility of the soil and promote better farm management. This type of test-demonstration farm is confined to those counties lying wholly or chiefly within the Tennessee River watershed.

In recognition of the value of these farms for testing fertilizer effects and in meeting the water-conservation and erosion-control requirements of the TVA, the Authority provides phosphatic fertilizers for use in growing soil-and-water-holding and soil-building grasses and legumes. The associations of farmers, working with the representatives of the College, carry on the program, and pay the freight and handling charges on the phosphates.

Statistics as of June 30, 1938, show that there were 11,832 of these farms, containing a total of 1,564,516 acres. All are located in counties within the Tennessee River watershed. Fuller data are given below under "Scope of All Test-Demonstration Farms."

This area program is a means of stabilizing and reclaiming communities becoming run-down because of ill-adjusted land use and consequent soil depletion. It develops community spirit and individual and neighborhood pride in cooperative effort.

(3) SCOPE OF ALL TEST-DEMONSTRATION FARMS

In order to give a picture of the location and scope of all the test-demonstration activities, Table 1 has been prepared. The data for the seven Valley States are presented for one group of 122 counties lying wholly or partly within the Tennessee River watershed and one group of 205 counties lying wholly or mostly outside the area. This makes a total of 327 counties. This latter number represents more than 10 percent of the counties in the United States.

In a few cases where a county lies mostly outside of the Valley area, it still is classed as a Valley county because of the importance either of the portion within the valley or of the work

being done in that portion. Two Tennessee counties classed as Valley counties do not contain test-demonstration farms.

The farms participating total 21,663, of which number 9,831 are farm-unit test-demonstration farms and 11,832 are in area or watershed test-demonstrations. Of the farm-unit farms, 6,348 are in the 122 Valley counties of the seven Valley States as are all the 11,832 farms in area and watershed test demonstrations, making a grand total of 18,180 farms in these Valley counties. In addition, there are 3,483 farm-unit test-demonstration farms in the 205 non-Valley counties.

TABLE 1.—*Summary of all Test-Demonstration Activities in both Valley and non-Valley counties of the seven Valley States as of June 30, 1938, including numbers of counties, farms, and acres, and of tons of phosphate distributed.*

| States by Valley and Non-Valley Counties | Counties Number | Farms in Test-Demonstrations | | | | Phosphates Distributed Tons |
|---|---|---|---|---|---|---|
| | | Farm Unit | | Area or Watershed | | |
| | | Number | Acres | Number | Acres | |
| In Valley Counties: | | | | | | |
| Alabama | 15 | 196 | 52,726 | 2,793 | 470,832 | 5,159 |
| Georgia | 9 | 432 | 87,031 | 1,030 | 121,827 | 3,576 |
| Kentucky | 7 | 368 | 65,842 | 50 | 4,796 | 1,095 |
| Mississippi | 4 | 151 | 25,343 | 1,073 | 101,796 | 2,011 |
| North Carolina | 15 | 1,092 | 138,876 | 419 | 32,249 | 5,015 |
| Tennessee | 61 | 3,692 | 631,597 | 2,673 | 272,186 | 21,226 |
| Virginia | 11 | 417 | 93,304 | 3,794 | 560,830 | 12,220 |
| | 122 | 6,348 | 1,094,719 | 11,832 | 1,564,516 | 50,302 |
| In Non-Valley Counties: | | | | | | |
| Alabama | 28 | 183 | 74,644 | ---------- | ---------- | 1,141 |
| Georgia | 31 | 458 | 118,563 | ---------- | ---------- | 1,967 |
| Kentucky | 42 | 1,102 | 197,972 | ---------- | ---------- | 2,030 |
| Mississippi | 22 | 450 | 135,667 | ---------- | ---------- | 2,531 |
| North Carolina | 47 | 802 | 150,708 | ---------- | ---------- | 2,385 |
| Tennessee | 2 | 25 | 4,473 | ---------- | ---------- | 82 |
| Virginia | 33 | 463 | 126,405 | ---------- | ---------- | 2,627 |
| Totals | 205 | 3,483 | 808,432 | ---------- | ---------- | 12,763 |
| Grand Totals | 327 | 9,831 | 1,903,151 | 11,832 | 1,564,516 | 63,065 |

As of June 30, 1938, the total area of all participating farms in the seven Valley States is 3,467,667 acres or about 5,775 square miles. Within these States, 1,094,719 acres are in farm-unit farms and 1,564,516 acres in area and watershed demonstrations in the 122 Valley-area counties, and 808,432 acres are in farm-unit test-demonstration farms in counties outside the Valley area. These data show that 2,659,000 acres, out of a total of 17,850,000 acres in farms in the Tennessee River watershed, are in test-demonstration farms organized for soil protection and building. This amounts to about 14.8 per cent of the total watershed area in farms.

As noted previously, the Tennessee Valley Authority has cooperated fully in this test-demonstration program because it aided the Authority to achieve its objectives of fertilizer testing, flood control, water and soil movement control, and reservoir protec-

tion. For these reasons, the Authority has furnished some 63,065 tons of concentrated phosphate fertilizers to aid in producing plant cover on eroding lands in the seven Valley States, to June 30, 1938. Of this total tonnage, 50,302 tons have been supplied to farm-unit and area test demonstrations in 122 Valley-area counties of the seven Valley States. The remaining 12,763 tons have been applied on farm-unit test-demonstration farms in 205 non-Valley counties of these same States.

Nearly all of this phosphate has been triple superphosphate, originally with a content of about 43% of $P_2O_5$ but more recently averaging about 45 percent. Very recently some 256 tons of calcium metaphosphate have been distributed and are included in the totals given.

The program of cooperative test-demonstration farms apparently has been very effective as a means of educating farmers on the value of land-use adjustment and on the help given by phosphatic fertilizers in making such adjustments. This is shown in part by the fact that when the Agricultural Adjustment Administration announced that farmers might receive triple superphosphate in place of money payments, they responded promptly and favorably. In the calendar year 1937, farmers in the northern four of the seven Valley States applied for and received some 24,675 tons from the AAA. In the calendar year 1938, they received 49,027 tons and had applied for additional quantities which were not available.

(4) POWER TERRACING OPERATIONS

The building of water-holding terraces on sloping fields is a most important part of erosion-control procedures. For farmers' teams and equipment, the building of such structures is a slow and laborious task. To speed up the protection of land and reservoirs, and to insure better engineering structures, it was necessary to demonstrate the operation of large-scale power terracing outfits and to aid in making business arrangements whereby associations of farmers might lease or purchase such outfits. The whole terracing program has been fitted into the program of readjusting agriculture to achieve erosion control and land-use adjustment through the testing of experimental phosphates.

The State College Extension Divisions and the Tennessee Valley Authority have cooperated in helping associations of farmers to make arrangements whereby they lease or purchase power terracing outfits. Sometimes the Board of County Commissioners sponsors the arrangement. The rental payments are applied on the purchase price, which averages around $4,500. The associations in turn rent these outfits to farmers at a fixed rate, usually $3.00 per hour. Some counties have purchased outfits outright and leased them to farmers on similar terms. Under these plans it is intended that the cost shall be self-liquidating within the effective lifetime of the machinery. Farmers have been taught also how to use their farm equipment effectively in terracing their lands. The State Colleges and the Authority have furnished

some technical planning and supervisory personnel in connection with running the necessary surveys and operating the equipment. The results obtained are presented later in Section E of this report.

### (5) RELOCATION OF DISPLACED RESERVOIR FAMILIES

In Tennessee, Alabama, and North Carolina, three dams have been built, and three are under construction, by the Tennessee Valley Authority. Thousands of acres above each dam will be flooded by the reservoirs created by the dams. The Authority purchases not only the actual reservoir area but also a narrow protective strip above high-water mark. This strip is obtained partly through the purchasing of entire farms and partly in order to control the borders and thereby prevent the direct washing of silt into the reservoirs.

Of all the families displaced by the purchase of these reservoir areas, approximately three-fourths lived on farms and the remainder in villages or towns. All are obliged to move to new locations as dam construction proceeds. Usually a period of at least two years elapses between the selection of a dam site and the point where the removal of dwellers from its reservoir area becomes pressing. That fact gives time for satisfactory relocation without the added burden of haste in decision and removal.

Data on the size of the reservoir areas, the total numbers of resident families, and the progress in relocation, with other facts, will be given under summarized results, in Section E of this report.

Naturally, the leaving of long-established residences and undertaking a new enterprise in a new community is a disturbing experience at the best. The mere act of relocating is only half of the total problem. The problem of getting established in the new enterprise and tied into the life of the new community is equally important. Relocated families have been assisted after settling in new neighborhoods, to give them aid in the handling of their new problems and to help them become acquainted with their new neighbors and community organizations. Because it takes a considerable time to make such readjustments, it will be necessary to continue this assistance and guidance over a period of years.

The Land-Grant Colleges, through their experiment stations and extension services, are charged with the duty of aiding farmers in the solution of their problems. Accordingly, they have endeavored earnestly to help all dispossessed families to relocate advantageously and satisfactorily, if the families wished such aid. Almost without exception, such assistance has been requested and appreciated. The great majority of the displaced families have preferred to remain in the counties where they had lived. A small percentage relocates in nearby counties, and a very few leave the area or the State.

The Tennessee Valley Authority is permitted, although not required, under the Act of Congress, to assist dispossessed families in relocating. The sudden need for relocating thousands of fami-

lies has thrown large and unexpected burden on the State Colleges affected. The Authority therefore has cooperated fully and effectively with the States through providing personnel in land appraisal and the various other activities necessary. It also has aided in providing a woman extension specialist to advise and assist the farm home-makers in their readjustments and the process of getting acquainted in their new communities. The Farm Security Administration of the U. S. Department of Agriculture and some other State agencies also have given assistance on some phases of the problem.

### (6) AGRICULTURAL TRAINING OF RESERVOIR-CLEARANCE EMPLOYEES

The men employed by the TVA to clear the trees and shrubs from the various reservoir sites have been recruited largely from the farms within or adjacent to the areas to be cleared. In order to spread employment during the depression, and to permit the men to work farms at the same time, most of them have been employed by the Authority on a part-time basis. A large part of these employees represented families living in the reservoir site and therefore obliged to relocate.

Under these conditions, it seemed to the Land-Grant Colleges of the States involved, and also to the Authority, that here was an excellent opportunity for giving agricultural education and training. The primary purposes were to train the employees (a) in the principles and practices of soil conservation and watershed protection, (b) in the principles of increased efficiency and self-sufficiency in crop and livestock production, (c) in farm and home planning, organization, and budgeting, and (d) in effective expenditure of the funds received from their part-time employment. Ordinarily, the farmer is contacted as soon as he becomes employed and an effort is made to assist him in adopting some part of the program on his own farm.

This program, like that of relocating displaced families, was carried on by the Agricultural Extension Services of the Land-Grant Colleges. This was done largely through the county agricultural advisors and home-demonstration agents. Some additional assistance was required for effective supervision and the Colleges were reimbursed by the Authority for this additional personnel. These farmers are aided in forming their own community groups and committees, through which the program operates.

These activities in agricultural extension education may be divided into three main groups, as follows: (1), adult and junior study and discussion clubs, usually meeting monthly; (2), organized demonstrations of approved farm, orchard, and garden methods and practices on the employee farms and in home gardens; and (3), cooperative use of Authority-owned lands by nearby farmers, the last discussed separately in the next paragraph. The results obtained are presented later, in Section E of this report.

#### (7) IMPROVEMENT OF AUTHORITY-OWNED RESERVOIR LANDS

In purchasing reservoir sites, the Authority buys a protective border strip of varying width lying above the high-water level of the future reservoir. The possession of this border strip makes it possible to prevent direct reservoir silting caused by the denuding or improper use of adjacent fields or by caving of the reservoir banks. It is desirable to use these borders wisely in the interests of recreation, wildlife development, forestry, or agriculture.

The several Valley-States Colleges of Agriculture are interested in these objectives and are cooperating with the Authority in achieving them. Already these protective borders have been created about reservoirs in Tennessee, Alabama, and Mississippi. Construction already started will create them presently in North Carolina and Kentucky.

In the lower reaches of the Tennessee River, where the lands are more level, these borders often consist of good agricultural lands. If these can be used agriculturally to the mutual advantage of the States, the Authority, and the farmers on adjacent farms, it is highly desirable to achieve that result.

The agricultural use of these lands comprises the cooperative growing of seed of annual lespedeza, and the leasing of other areas for pasture and meadow. The agricultural practices to be followed are recommended by the State Colleges of Agriculture, and the business agreements are made by associations of farmers. Supervision is provided cooperatively by the State Agricultural Extension Service and the Authority.

## E. SUMMARIZED RESULTS OF COOPERATIVE ACTIVITIES

The preceding Section (D) of this statement has described the various cooperative relations of the Valley-States Land-Grant Colleges with the Tennessee Valley Authority. The present Section (E) summarizes the results obtained from these cooperative activities. The results obtained by the State Agricultural Experiment Stations in their controlled experimentation in greenhouse, plot, and field, will be presented first. These will be followed by the summarized results of the educational and demonstrational activities. Some observations on the importance of phosphorus and the responsibilities and problems of the Land-Grant Colleges precede the discussion of results.

### 1. THE SPECIAL IMPORTANCE OF PHOSPHORUS

When the representatives of the Land-Grant Colleges and other agricultural leaders were consulted by the Authority, they unhesitatingly declared that phosphorus was the most important problem in the fertilizer field. Phosphorus is widely needed by the soils of the country. The natural phosphates (raw phosphate rock) require extensive processing to render the phosphorus readily soluble and available to plants. Phosphorus can be supplied to crops only by direct application and cannot be obtained

from the air. Phosphates are increasingly necessary to grow the cover plants to protect agricultural lands from erosion and to rebuild the fertility of our older areas to profitable levels of crop production. The annual use of much larger quantities is necessary to undo the damage of the past and to maintain and improve the conditions of the present.

### A. NEED FOR CONCENTRATED PHOSPHATIC FERTILIZERS

Transportation costs comprise a large part of the total cost of fertilizing materials. The phosphatic fertilizers most commonly used are of low concentration (16% or rarely 20% $P_2O_5$) so that transportation costs, per unit of phosphorus, are relatively high. Even these phosphatic materials of low concentration commonly are used in commercial mixtures which still further reduce the concentration of the phosphates.

More than 90 per cent of the phosphate reserves of the United States are in the Far West, quite remote from the eastern agricultural areas where the greater part of the supplies are needed. If the annual domestic use of phosphatic fertilizers is stepped up to several times the present rate, as the needs of the land require, the southeastern reserves will soon be exhausted. An enormously long freight haul then will be necessary to bring western phosphates to the depleted South and East. It seems highly important, therefore, to develop methods necessary to manufacture materials of the highest possible concentration and thereby to reduce the cost of transportation per unit of phosphorus and permit the effective utilization of the western reserves.

In view of the facts just recited, the Authority has devoted most of its fertilizer program to the development and production of phosphatic materials, and especially to those of higher concentration. It also has developed methods for the manufacture and transportation of the element phosphorus itself, which is the last step in the commercial concentration of phosphorus for long shipment.

### B. NEW MATERIALS PRODUCED BY THE AUTHORITY

Through the use of its chemical plant and electric power facilities available at Muscle Shoals, the Authority has produced several kinds of phosphates in quantities suitable for extensive plot testing by experiment stations. Two phosphates and one slag byproduct have been made in sufficient quantity for large scale practical tests and demonstrations by farmers, under farm conditions.

The experimental phosphatic materials and byproducts which have been produced thus far by the Authority are briefly described below.

(1) Monocalcium and dicalcium phosphate in relatively pure form. These were produced during the initial investigation and production in the first year of operation (1933-34).

(2) Triple superphosphate made by pyro-electric methods, and now containing about 45 percent of $P_2O_5$. This phosphate is made by the production of liquid phosphoric acid by the furnace method

and the use of that acid to treat rock phosphate as in the usual process for the production of triple superphosphate. This material was developed in a pilot plant in 1934 and on a semicommercial-plant scale in 1935.

(3) Calcium metaphosphate, a new commercial product containing 62 to 65 percent of $P_2O_5$. It was developed on a pilot-plant scale in 1936 and 1937 and on a semicommercial-plant scale in 1938. The production of this material involves a considerable modification of the method for producing triple superphosphate.

(4) and (5) Liquid phosphoric acid and solid phosphorus, the one with a phosphoric-acid equivalent of 82 percent, and the other of 223 percent. These are intermediate products that can be reclaimed in connection with the making of triple superphosphate and calcium metaphosphate and both have been produced in considerable quantities. These have a wide range of possible uses that have been very little investigated, and include not only agricultural but also munition and industrial utilization.

(6) Fused rock phosphate is the newest product, and results from merely heating rock phosphate to drive off most of its fluorine, the presence of which seems to make rock phosphate so unavailable. It contains 25 to 32 percent of phosphoric acid, depending on the quality of the rock used.

(7) Calcined rock phosphate was produced in small amount as a step toward the development of fused phosphate and has about the same composition.

(8) Calcium-silicate slag is a byproduct resulting from the first step in the production of both triple superphosphate and calcium metaphosphate. It accumulates in large quantities, equivalent to about a ton of slag for each ton of triple superphosphate produced. This material has an available lime content comparable with that of limestone. When pulverized, it may be valuable as a liming material.

## 2. LAND-GRANT COLLEGE RESPONSIBILITIES AND PROBLEMS

It is the task of the Valley-States Land-Grant Colleges, under their cooperative arrangements with the Authority, to undertake three successive activities in furthering the program of phosphate production and testing in land-use adjustment. The requirements of this program have developed some related problems and caused some additional activities.

### A. PHOSPHATE RESEARCH AND EXPERIMENTATION

The Colleges first arrange for a study of the chemical, physical, and other properties of these materials in the laboratory. Next, they conduct successively larger-scale tests on different crops, in greenhouse pots, in Station and Substation plots, and in controlled fields, located in the different portions of each State, on the various major soil types. These tests are made to determine the effect of the new materials under the different combinations of crop and soil conditions, in comparison with the phosphate

fertilizers already in common use. The tests serve also to guide the Authority in determining whether to expand the production of each material tested.

### B. TEST-DEMONSTRATIONS ON FARMS

Finally, when the controlled investigations of the Agricultural Experiment Stations are sufficiently advanced, if the results from the material continue to be promising, it moves out into the wider range of test-demonstrations on farms. These also are conducted under all conditions of soil and types of farming. These test-demonstrations serve to familiarize farmers with the new material and the conditions for its effective use and to bring about its adoption by them in ordinary farm practice if the results warrant. These extensive farm test-demonstrations also give the Authority the opportunity to measure the economic return produced by a given phosphatic material, as required in the Act. That these operations on private farms contain elements of both experimentation and demonstration is recognized in the use of the term "test-demonstration" to designate them. The requirements created by this combination of activities will be discussed more fully below.

### C. LONG-TIME RESULTS REQUIRED FOR SAFE CONCLUSIONS

The time element, or duration of the experiments and test demonstrations, is important where results must be interpreted through the measurement of soil fertility and crop production. Climatic and soil factors are so variable that the results of several years must be in hand before dependable conclusions can be drawn.

The Authority is authorized to cooperate with National, State, or local experiment stations or demonstration farms, and with farmers and associations of farmers, for the use of new forms of fertilizers or fertilizer practices during the initial or experimental period of their introduction, and to make similar arrangements for preventing soil erosion by the use of fertilizers or otherwise. It further is authorized to make donations of fertilizer products for distribution through the agricultural colleges or otherwise for experimentation, education, and introduction of their use in cooperation with practical farmers so as to obtain information as to their value, effect, and best method of use. The Authority likewise is authorized to arrange with farmers and farm organizations for large-scale practical use of the new forms of fertilizer under conditions permitting an accurate measure of the economic return they produce.

This is the wide scope of the program which the Valley-States Land-Grant Colleges are conducting in cooperation with the Authority. It is obvious that if the difficult objectives specified in the Act are to be attained, these activities must be continued for many years. Only thus can the value, effect, and best methods of use of fertilizers be determined and the economic return they produce be accurately measured. For these reasons, the cooperating States must be assured of a dependable annual supply of

the new fertilizer materials for several years to come. Otherwise, the investment already made in the organization and conducting of these station and farm activities will be largely lost and the determinations required by the Act cannot be made.

#### D. SOLVING THE ADDITIONAL PROBLEMS CREATED

Much more is involved in this cooperative program than merely the experiment station tests of the new fertilizer materials and their large-scale demonstration to practical farmers. Even in the test-demonstration program itself the records of conditions and treatments, and the interpretation of results, are essential and these constitute or involve research activities.

The necessity of conducting the test-demonstrations on many different types and subtypes of soil, in order to measure the value and effect of fertilizer use, requires an accurate knowledge of the distribution of the numerous soils. The prevention and control of water and soil movement likewise require a knowledge of the soil types involved, for these vary greatly in erosiveness and in response to treatment and to terracing. Terracing as a means to erosion control requires widespread demonstration and a study of the cost factors. These are the reasons for conducting the detailed cooperative survey (classification and mapping) of the soils which is under way in six of the States, as reported herein.

The land-use adjustment phases of the program of fertilizer use require changes in crops and cropping practices, and consequently in the farm organization. These create new problems of crop and soil management, of livestock husbandry and animal nutrition, of the use of new or improved farm machinery, and of the processing and marketing of farm products. All of these factors must be studied in order to measure accurately the economic returns produced by the new fertilizer materials. They require the solution of problems in agronomy, animal husbandry, agricultural engineering, agricultural economics (including farm management), and rural sociology.

### 3. RESULTS OF STATION RESEARCH AND EXPERIMENTATION

The results of the research and experimentation conducted by the Agricultural Experiment Stations of the seven Valley-States Land-Grant Colleges, in cooperation with the Tennessee Valley Authority, are summarized hereunder. The presentation will include the scope of the work, the methods employed, the stage of development of each project, and, so far as possible, the results obtained to the close of June 30, 1938. Statements of funds and personnel employed in the cooperative projects have been tabulated and mimeographed, but are not included in this report.

#### A. PRELIMINARY RESEARCHES ON PHOSPHATES

In 1933-34, the first fiscal year of operation of the Muscle Shoals plant by the Authority, the Tennessee Station chemist developed procedures for the production of monocalcium and dicalcium phosphates of high purity. Those were manufactured by the Author-

ity in ton lots and were utilized by all the Valley-States Stations in their field-plot tests in 1934. Magnesium phosphate also was produced and submitted to tests under crops.

The Tennessee Station has continued to collaborate with the Authority chemists in the study of the chemical composition and physical characteristics of the several materials produced. Numerous mixtures of phosphatic fertilizers have been made with limestone, dolomite, and slags, including the calcium-silicate slag produced as a byproduct by the Authority, to determine the compatibility of the several materials. Nine scientific articles in technical journals have resulted from these studies of the Station and are listed below.*

### B. EXPERIMENTS ON PHOSPHATE EFFICIENCY

This series of experiments has included quick tests of soil needs and phosphate availability, and very extensive experiments on phosphate value and use conducted in greenhouse pots, field cylinders (rims), and station plots. Some minor studies on the use of special phosphate materials in animal nutrition and silage making also are under way.

#### (1) QUICK TESTS OF SOIL NEEDS AND PHOSPHATE AVAILABILITY

Field-plot experimentation necessarily is a slow method of testing the quality of any fertilizer material. It seemed worth while, therefore, to investigate the merits and adaptation of the quick methods such as the Naubauer and the fungus methods as developed at the Wisconsin Agricultural Experiment Station. The former utilizes 17-day growths of rye in the laboratory. The latter uses the growth of particular fungus species, especially *Cunninghamella,* to measure the need of phosphorus and potash in the soil and the availability of these elements when supplied by different fertilizer materials. Five thousand tests with rye have been made on several different types of soil, with an equal number of plant analyses for phosphate, 257 analyses for potassium, and 378 determinations of soil acidity.

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*a. Comparison of Gravity and Suction in Washings to Remove Water-Soluble $P_2O_5$ from Analytical Charges. W. H. MacIntire, R. M. Jones, and L. J. Hardin. Jour. Assoc. Off. Agr. Chemists 18:301—. May, 1935.

b. A Modified Technic for the Determination of Citrate-Insoluble $P_2O_5$. W. H. MacIntire and L. J. Hardin. Jour. Assoc. Off. Agr. Chem. 18:297—. May, 1935.

c. Calcium Silicate Slags: Properties of Quenched and Unquenched Slags and Effects of Their Admixtures with Phosphatic Fertilizers. W. H. MacIntire, L. J. Hardin, and F. D. Oldham. Indus. and Eng. Chem. 28:48-57. January, 1936.

d. Phosphate Fertilizer Mixtures: Chemical Changes and Physical Effects Induced in Mixtures of Triple Superphosphate with Dry and Wetted Limestone and Dolomite. W. H. MacIntire, L. J. Hardin, and F. D. Oldham. Indus. and Eng. Chem. 28:711-717. June, 1936.

e. Calcium Metaphosphate Fertilizers: Chemical Composition and Properties. W. H. MacIntire, L. J. Hardin, and F. D. Oldham. Indus. and Eng. Chem. 29:224-234. February, 1937.

f. Development of $P_2O_5$ Insolubility in Phosphatic Mixtures: The Formation of Fluorapatite as Its Cause. W. H. MacIntire, L. J. Hardin, F. D. Oldham, and J. W. Hammond. Indus. and Eng. Chem. 29:758-766. July, 1937.

g. Direct Determination of Available $P_2O_5$ Content of Fertilizers. W. H. MacIntire, W. M. Shaw, and L. J. Hardin (Preliminary Publication). Jour. Assoc. Off. Agr. Chem., 21:113-121. February, 1938.

h. Direct Determination of Available $P_2O_5$ Content of Fertilizers. W. H. MacIntire, W. M. Shaw, and L. J. Hardin (Amplified Publication). Ind. and Eng. Chem., Anal. Ed., 10:143-152. March, 1938.

i. Behavior of a New Source of Readily Available Magnesium for Phosphatic Fertilizers. W. H. MacIntire, L. J. Hardin, and F. D. Oldham. Indus. and Eng. Chem. 30:651-659. June, 1938.

Of these two quick methods, only the fungus method was indicated as having considerable value in the measurement of the efficiency of the new phosphates and their adaptation to different soils.

Changes that phosphates undergo in the soil, with special reference to the new materials, also have been the subject of considerable study.

### (2) GREENHOUSE POT EXPERIMENTS

Tests in greenhouse pots have been conducted at the Tennessee and Kentucky Stations. These serve as pathfinders for the more extensive plot tests.

At the Tennessee Station, 3,200 pots of growing crops, on several types of soil, have been treated with the different new phosphates and with a variety of limestone, dolomite, and slag supplements. The object is to secure information on the reaction between these soils and the several fertilizer combinations. The procedures have included placing the fertilizer in both deep and shallow layers, and mixing it completely with the soil. The object in these tests is not alone to measure the response of the plant but also to get information as to the reason for the response in a way that will throw light on the basic principles of phosphate fertilization. A large volume of information is being accumulated from this work.

At the Kentucky Station, tobacco, corn, wheat, alfalfa, rye, red clover, and lespedeza have been grown on several phosphate-deficient soils during three years. These have been treated with monocalcium, dicalcium, and tricalcium phosphate, in comparison with 20-percent superphosphate, and with other fertilizer and lime supplements. In addition to the crop yield, the phosphate recovered in the crops from the different treatments was determined. In the 1936-37 tests, triple superphosphate, calcium metaphosphate, fused rock phosphate, raw rock phosphate, and colloidal phosphate were included.

The availability of the phosphates varied with the crop, the soil, and particularly the liming treatment. On the average, however, there was very little difference between ordinary superphosphate, triple superphosphate, monocalcium phosphate, dicalcium phosphate, calcium metaphosphate, and fused rock phosphate. Tricalcium phosphate was appreciably less available than the preceding, and the availability of rock and colloidal phosphates was low. Equal amounts of phosphorus were applied in all of the phosphates.

### (3) FIELD CYLINDER (RIM) EXPERIMENTS

Triple superphosphate was moved directly from greenhouse pot experiments into field plot tests, beginning in 1935. Calcium metaphosphate, on the other hand, has been submitted to an intermediate experiment in comparison with other phosphates. In 1936 and 1937 it was tested in 135 field cylinders or rims about 3 feet in diameter, at the Tennessee Station. This was chiefly a study of the effect of fineness of grinding, because it is a glassy

material quite insoluble in large particles. Oat, millet, Sudan grass, and Austrian winter pea have been used as the indicator crops. The time element appears to be involved with the fineness in the determination of availability. From this series of experiments the Director of the Station concludes that "the results indicate that metaphosphate may be in a superior class so far as after-effects are concerned."

### (4) FIELD PLOT EXPERIMENTS

This series of experiments has been the most extensive phosphate work carried on by the Valley-States Experiment Stations. It has been in progress on a large scale in all of the seven States during the last four years. Each Station determines its own line of procedure and comparisons according to its own conditions and its knowledge of the problems involved. The plan followed, including the crops used, therefore, has differed considerably in the several States. Some States have concentrated their tests on a single crop, such as cotton. Others have used several staple crops and rotations, such as would be employed in practical farm operations. In addition, they have used fertilizer combinations supplementing the phosphates, and also rates and methods of use of lime or other amendments.

Literally thousands of plots have been involved, when the replications necessary to increase the accuracy of the results are considered. The aim has been to place tests on the leading soil groups of each State. The several Authority-produced materials have been carried in these tests for varying numbers of years, depending on when they first became available. The plan in all cases is to run the tests on any particular material for not less than five years in order to minimize the variations in seasonal weather conditions. Publication of Station results for any particular material normally may be expected at the end of a five-year period.

(a) *Monocalcium, Dicalcium, and Tricalcium Phosphate.* Work with these materials began in 1934. Mississippi, North Carolina, and Virginia have carried experiments with them through four years. The other States have substituted triple superphosphate on the monocalcium plot, beginning with 1935. The basis of comparison of all TVA phosphates is the yield produced by ordinary 16-percent or 20-percent superphosphate, supplemented with nitrogen and potash. This yield is rated as 100. The carriers of these latter elements have varied in the different States. The Authority materials also are supplemented with the same nitrogen and potash carriers, for the purpose of comparisons.

As an average of all soils and crops, the unfertilized plots have produced an average yield of 64.5 in a total of 650 tests. Where nitrogen and potash were used, without phosphate, the average yield has been 79.9 in 3,654 tests. The difference between this figure and 100 may be regarded as the average response of all unlimed soils and crops to phosphate.

Some soils have given a relatively large response, but others no response or a negative one. Different crops also differ in their response on the same soil. The responses have been divergent, some below and some above the average and also above and below the base treatment with 16-20-percent superphosphate.

With these facts in mind, it may be stated that monocalcium phosphate has produced a yield of 96.4 as the result of 823 tests during four years. Dicalcium phosphate has given an average yield of 99.7. It must be remembered that the soils and crops, on which the different fertilizers have been used from year to year, have varied considerably. More accurate comparisons, probably, can be made from selected tests on particular soils and with particular crops, and especially in conjunction with lime supplements.

In Alabama, in 285 experiments, dicalcium phosphate produced a relative yield of 99 and tricalcium phosphate one of 95. In Kentucky, on eleven experimental fields on as many different soil conditions, on unlimed and limed soil, dicalcium and tricalcium phosphate produced the following yields, compared with ordinary superphosphate (Table 2).

TABLE 2.—*Crop yields produced by dicalcium and tricalcium phosphate in comparison with no phosphate and ordinary 16-20-percent superphosphate, on unlimed and limed soils.*

| TREATMENTS | Unlimed | | | Limed | | |
|---|---|---|---|---|---|---|
| | Corn | Wheat | Legume Hay | Corn | Wheat | Legume Hay |
| No phosphate, N & K only | 73.8 | 46.2 | 84.3 | 91.8 | 54.8 | 109.8 |
| Ordinary superphosphate with N & K | 100.0 | 100.0 | 100.0 | 117.8 | 116.8 | 148.1 |
| Dicalcium phosphate with N & K | 98.1 | 106.5 | 101.8 | 112.8 | 122.9 | 153.4 |
| Tricalcium phosphate with N & K | 93.3 | 100.0 | 100.3 | 105.9 | 100.5 | 142.2 |

(b) *Triple Superphosphate on Row and Rotation Crops.* The plot tests with this material are by far the most extensive and long-continued of those on any materials developed by the Authority. Experiments were started in all Valley States in 1935 and three years of results are available. It enters into several different types of experiments in most of the States, involving comparisons with several different kinds of phosphates as well as ordinary 16-20-percent superphosphate and several kinds of lime supplements.

The rate of application of $P_2O_5$ has ranged from 30 to 40 pounds per acre on row crops in most of the States, to 60 pounds on cotton in Alabama and North Carolina. Many other details of the conduct of the experiments have varied from State to State.

Alabama has carried a standard set of plot treatments on the cotton crop, beginning with 14 and expanded to 17, including triple superphosphate, in from 101 to 107 different experiments in each of the three years. These were placed in six major soil regions over the State, each involving several types of soil. In

Alabama, from 285 tests with seed cotton on all soils, triple superphosphate ranked 97 compared with ordinary 16-20-percent superphosphate at 100.

Georgia has a six-plot layout, unlimed and limed, that has been used in 107 experiments, all on cotton, and about equally divided between the Coastal Plain and the Piedmont-Mountain soils with a wide variety of soils in each division. Triple superphosphate also enters into two other experiments with lime and sulfur supplements.

Kentucky conducted her chief experiment with triple superphosphate in a 13-plot layout including duplicates, without and with lime, at 11 locations representing the main soil groups, in a three-year rotation of corn, wheat, and legume hay. Triple superphosphate also enters into tests of lime and slag amendments at one or two locations. The Kentucky Station states that "ordinary superphosphate and triple superphosphate were about equally effective" on the eleven fields.

Mississippi has carried on some 77 experiments in two layouts, one of 9 and the other of 11 treatments, distributed on about 27 types of soil, in 23 counties. These tests were mostly with cotton but some on corn, small grain, and legumes.

North Carolina has an extensive system of plot layouts and rotations, without and with lime. The rotations range from two to four years and involve corn, wheat, and hay with legumes, as well as cotton. From 10 to 15 experiments are carried on, representing nearly as many types of soil, from the Blue Ridge Mountains to the Coastal Plain. Triple superphosphate also is represented in three experiments designed primarily to test calcium metaphosphate without and with lime. North Carolina states that "from the limited amount of data obtained to date, triple superphosphate, on most soils, appears to be a satisfactory source of phosphoric acid as compared with standard sources."

Tennessee has an extensive layout of 45 plot treatments including several phosphate carriers along with triple superphosphate, with different nitrogen carriers and lime supplements, on several types of soil in the eastern part of the State, on corn, wheat, potato, soybean and cowpea, and carried for one or two years. Triple superphosphate also enters into three other experiments designed primarily to test metaphosphate, fused phosphate, and lime supplements with a variety of crops, including legumes. The Tennessee Station states that "triple superphosphate proved to be a firstclass source of phosphoric acid for fertilizer use."

Virginia has carried a 10-plot layout including several carriers of phosphate, some with lime, slag, and sulfur supplements, at 19 locations, covering all the main soil groups and using a variety of crops and crop rotations, usually with a legume included. Most of these experiments are arranged with farmers or are on substation farms, so that in all cases the details of the experiments are under the close supervision of the Experiment Station. The Virginia Station states that the average yield (without lime) from triple superphosphate on all soils and with all crops has been

within three percent of the yield from ordinary 16-percent or 20-percent superphosphate.

The consolidated weighted average relative yields on all soils in all the seven Valley States for the three years, in comparison with 16-percent or 20-percent superphosphate, without and with lime, are given in Table 3, with the "no phosphate" and the "no fertilizer" averages included for comparison:

TABLE 3.—*Consolidated relative average yields produced by triple superphosphate in comparison with no fertilizer, no phosphate, and ordinary 16-percent or 20-percent superphosphate, on unlimed and limed soils.*

| | Unlimed | | Limed | |
|---|---|---|---|---|
| | Number of Tests | Relative Yield | Number of Tests | Relative Yield |
| No fertilizer | 650 | 64.5 | 200 | 77.5 |
| N & K without phosphorus | 3,654 | 79.9 | 984 | 81.4 |
| 16% or 20% superphosphate with N & K | 3,943 | 100.0 | 1,432 | 111.0 |
| 43% triple superphosphate with N & K | 3,138 | 98.0 | 2,920 | 106.1 |
| 43% triple superphosphate with N & K and sulfur | 1,292 | 100.9 | No data | |

(c) *Triple Superphosphate on Pasture.* The pasture land has been a neglected part of most farms, in spite of the fact that a good pasture provides about the most economically-produced nutriment for livestock and the further fact that a good pasture cover has a very high soil-protective and soil-building value. In recent years special attention is being given by the experiment stations to the fertilization and other improvement of pasture land. This is especially needed in the Southern States where erosion is such a serious problem. Involved in the pasture problem is the development of an adequate proportion of legume forage to provide as nearly as possible the requisite nitrogen for the total growth. Phosphates, usually with lime, are especially needed for this purpose on most soils.

The Valley-States Experiment Stations have established special pasture top-dressing projects on several different types of soil in each State. Triple superphosphate is used, in comparison with ordinary superphosphate and sometimes with other phosphates including metaphosphate. Usually potash is applied, and, in some States, a lime supplement also, but no fertilizer nitrogen is used.

The first of these tests was started in 1936 and these projects are in different stages of development in the several States. They require considerable time to get under way effectively and must continue for a relatively long period to secure dependable results.

In Alabama, on five stations, triple superphosphate (90 pounds $P_2O_5$ per acre) on ungrazed plots, produced a 2-year relative yield of 101, with a range on different soils from 91 to 120, compared with ordinary superphosphate.

In Kentucky six series of plots have been started, including the use of limestone, dolomite, and calcium silicate slag as supplements. Ninety pounds of phosphoric acid per acre were applied in the spring of 1937. Weather conditions in 1937 were unfavor-

able but the beneficial effects of the treatments are evident. Analyses of the herbage for phosphorus are being made and already it is concluded that the phosphorus content is increased on phosphate-lean soils. This, in turn, is highly beneficial to animals grazed on this herbage.

Georgia and Virginia have pasture experiments well started.

(d) *Calcium Metaphosphate.* This very highly concentrated material (64 percent phosphoric acid) first became available for field-plot experiments in a small way in 1936. While the cylinder (rim) tests, referred to above, involved the question of fineness of grinding of this glasslike material, that used in field tests has been ground to a standard fineness. Some of the Valley States have set up additional experiments with metaphosphate in comparison with other phosphate carriers on one or more soils. Others have extended their standard series to include plots treated with metaphosphate. The range of soils and crops tends to be much the same as in the tests of triple superphosphate.

This material has a distinctive chemical characteristic, in comparison with other materials produced. The indications are that in solution the molecule ($Ca(PO_3)_2$) is relatively unstable in contact with soil material and readily enters into new molecular arrangements which introduce additional problems in the study of its reactions with soils and crops, and of its availability.

Like the other Authority-produced phosphates, the yields it produces are compared with those produced by ordinary 16-percent or 20-percent superphosphate under the same conditions.

Alabama states that "calcium metaphosphate produced an average increase of 17 percent less than the increase due to commercial superphosphate."

North Carolina states that, "from the results of one year on two fields, replicated five times, calcium metaphosphate appears to be more efficient when used with limestone filler than when used without limestone."

The Tennessee Station states that while the tests thus far have not been extensive, "in a majority of trials on wheat it gave yields as good or better than those from 16-percent superphosphate."

Virginia has found, thus far, that in an average of all tests, excluding tobacco, metaphosphate has produced within two percent of the yield produced by 16-percent superphosphate.

In the general average of results of 580 tests available in the Valley to date, metaphosphate has produced a relative yield of 96.5 compared to ordinary superphosphate. When used with lime in 40 tests it has given an average yield of 112.8 compared with an average of 105.3 from 2,430 tests of 16-percent superphosphate with lime.

(e) *Fused Rock Phosphate.* This material was not placed in field-plot tests until 1937. In general, plots treated with fused rock phosphate have been added to whatever plot series were being treated with other Authority-produced phosphates. From the reports available on 188 tests, the relative average yield has been 98.7, without lime supplement.

(f) *Calcium-Silicate Slag.* It has been pointed out that this material is an abundant byproduct from the production, by electro-pyrotechnic methods, of triple superphosphate, metaphosphate, liquid phosphoric acid, and solid phosphorus by the Authority. Laboratory tests indicate that it has about the same content of calcium-oxide equivalent as limestone and dolomite, and that in pulverized slag these constituents are relatively soluble in moist soil. The slag also carries about 30 pounds of phosphoric acid per ton, that may be available to crops. These facts point to the possible value of the pulverized slag for use on soil in need of those constituents.

Beginning in 1935, all of the Valley-States Stations added, to one or more of their plot series, new plots to be treated with this slag, used as a lime supplement in comparison with limestone or dolomite. It was subjected to the same range of soil and crop conditions as the other materials. The results of all available tests during three years are summarized in Table 4. Manifestly the field tests of this slag material need to be continued and extended.

TABLE 4.—*Consolidated relative average yields produced by calcium-silicate slag used as a lime substitute in comparison with limestone and dolomite.*

| TREATMENTS | Number of Tests | Average Relative Yield |
|---|---|---|
| 16% or 20% superphosphate with N and K | 3,943 | 100.0 |
| 43% triple superphosphate with N and K | 3,138 | 98.0 |
| 16% or 20% superphosphate with N and K plus limestone or dolomite | 1,432 | 111.0 |
| 43% triple superphosphate with N and K plus limestone or dolomite | 2,920 | 106.1 |
| 16% or 20% superphosphate with N and K plus slag | 12 | 96.0 |
| 43% triple superphosphate with N and K plus slag | 910 | 103.8 |

(5) ANIMAL-NUTRITION AND SILAGE-MAKING STUDIES

When phosphate is applied to the soil, its full benefit does not stop with any increased yield produced. Not only the kind and quantity of the crop produced is influenced but also the chemical composition, including the phosphorus content. This in turn is known to increase the nutritional value of such material to animals by which it is consumed.

Analyses of phosphated forage by the Kentucky and some other Stations show, in general, an increase in phosphorus content of the herbage.

Further, the use of phosphate-mineral supplements in animal feeding now is a common commercial practice. The larger amount of phosphate in the manure of such animals, when returned to the soil, has all the values of direct phosphate fertilization.

The nearly fluorine-free dicalcium phosphate, developed and produced by the Authority, seems especially adapted for use as a phosphate mineral supplement. Feeding trials carried on by the Tennessee Station, with white rats, have demonstrated that this material has an efficiency equal to the best known commercial phosphate supplements for animal feeding.

It now is well established that any kind of green herbage, including legumes, can be preserved in the silo if enough acid is provided to prevent decay. The liquid phosphoric acid produced by the Authority seems to be adapted, along with other mineral acids, for this purpose. When used in adequate amount, silage of good quality is produced and the indications are that a very large proportion of such phosphorus is reclaimed in the manure and will go far as a substitute for phosphate fertilizer. Used in this way, the liquid phosphoric acid thus performs three services: (a) preservation of the silage, (b) phosphate supplement to the ration, and (c) phosphate fertilizer for the land. The Tennessee, North Carolina, and other State Stations are conducting experiments on the use of Authority-produced phosphoric acid for these purposes.

### C. SOIL-SURVEY AND LAND-USE STUDIES

It is now widely recognized that it is necessary to have a knowledge of the nature, slope, condition, and properties of the soil to a considerable depth, both on the areas where fertilizers and other methods of soil treatment and different varieties of crops are under test, and on the much larger areas of farm land where the results of such tests are to be applied. The same results from treatments can be expected only to the extent that the soil conditions are approximately identical.

Such information on soil condition has been seriously lacking over large areas of the Tennessee River watershed, where the programs of tests of Authority phosphates, and the readjustment of farm organization for better watershed protection and other purposes, are being conducted most intensively by the Land-Grant Colleges.

The soil survey as developed during 40 years by the Soil Survey Division of the Federal Bureau of Chemistry and Soils is the best known method of securing and recording this necessary soil information, and many States already have cooperated in conducting it within their borders. Accordingly, an arrangement was reached, in 1935, between the Soil Survey Division, the several Valley-States Experiment Stations, and the Authority, for the speeding up and extension of such surveys in the Tennessee Valley area. The Authority contributed funds for the employment of men and for field expenses.

The survey operations in the Valley States have been concentrated in the Tennessee River watershed and the States have provided additional men and facilities. These surveys have been made in such a way that the areas of the several types of soil can be grouped together to form a map of the land indicating its probable best use for farming or other rural purposes.

The intensified soil survey has carried on regular soil survey operations on a field scale of about 2.6 inches, and published surveys of 1.3 inches, per mile. It also has made special large-scale surveys of many farms and area projects where fertilizer tests are being conducted, and of much of the protective border lands acquired by the Authority in connection with the construction of

reservoirs. These special surveys aid in formation of plans for the most suitable utilization of such lands.

The survey of the Belfast Mills area in Virginia is a good example of the first or area type, where an inventory was made of the present conditions and use of the land, to be contrasted with conditions after a few years of phosphate treatment and farm readjustment. The survey of the Wheeler Reservoir lands is a good example of the latter type.

The cooperative survey of Valley Counties was begun in Jefferson County, Tennessee, in June, 1934. Three counties were completed in the fiscal year 1936, eleven in 1937, and four counties and two areas in 1938, making a total of 18 counties and two areas in the three years. These 20 completed counties and areas contain 8,442 square miles or one-fifth of the area of the Tennes-

TABLE 5.—*Progress of soil survey, showing, by States, for fiscal years to June 30, 1938, the numbers of counties and special areas surveyed or under survey, the year in which completed, and the acres surveyed in each year, with totals.*

| STATE AND COUNTY OR AREAS | Year Completed | Square Miles Mapped | | | | | |
|---|---|---|---|---|---|---|---|
| | | In Fiscal Year Ending June 30, | | | | County Totals | State Totals |
| | | 1935 | 1936 | 1937 | 1938 | | |
| Alabama: | | | | | | | |
| Guntersville and Wheeler Area | 1938 | ---------- | ---------- | 90.5 | 157.2 | 247.7 | 247.7 |
| Georgia: | | | | | | | |
| Catoosa | 1937 | ---------- | 22.5 | 146.5 | ---------- | 169 | |
| Dade | 1936 | ---------- | 195 | ---------- | ---------- | 195 | |
| Union | ---------- | ---------- | ---------- | ---------- | 241.5 | 241.5 | 605.5 |
| Kentucky: | | | | | | | |
| Calloway | 1937 | ---------- | 239 | 173 | ---------- | 412 | |
| Marshall | ---------- | ---------- | ---------- | 11.5 | 312 | 323.5 | 735.5 |
| Mississippi: | | | | | | | |
| Alcorn | ---------- | ---------- | ---------- | ---------- | 52 | 52 | |
| Tishomingo | 1937 | ---------- | 256 | 165 | ---------- | 421 | 473.0 |
| North Carolina: | | | | | | | |
| Clay | 1936 | 40 | 180 | ---------- | ---------- | 220 | |
| Henderson | 1937 | ---------- | 283 | 75 | ---------- | 358 | |
| Jackson | ---------- | ---------- | ---------- | 33 | 303 | 336 | |
| Madison | 1937 | 15 | 240 | 179 | ---------- | 434 | |
| Mitchell | ---------- | ---------- | ---------- | ---------- | 61 | 61 | |
| Swain | 1938 | ---------- | 27 | 309 | 217 | 553 | |
| Transylvania | 1938 | ---------- | ---------- | 171 | 208 | 379 | 2,341.0 |
| Tennessee: | | | | | | | |
| Bedford | ---------- | ---------- | ---------- | 33.5 | 290.5 | 324 | |
| Cumberland | 1938 | ---------- | ---------- | 246.5 | 423.5 | 670 | |
| Hamilton | 1937 | ---------- | 279.5 | 268.5 | ---------- | 548 | |
| Humphreys | 1937 | ---------- | 337.5 | 205.5 | ---------- | 543 | |
| Jefferson | 1936 | 261.5 | 54.7 | ---------- | ---------- | 316.2 | |
| Lincoln | 1937 | ---------- | 334 | 236 | ---------- | 570 | |
| Norris Area | 1938 | ---------- | ---------- | ---------- | 413.8 | 413.8 | |
| Rhea | ---------- | ---------- | ---------- | ---------- | 44.5 | 44.5 | |
| Roane | 1937 | ---------- | 248 | 132 | ---------- | 380 | 3,809.5 |
| Virginia: | | | | | | | |
| Russell | 1937 | ---------- | 126.5 | 342.5 | ---------- | 469 | |
| Scott | ---------- | ---------- | ---------- | ---------- | 41.5 | 41.5 | |
| Smyth | ---------- | ---------- | ---------- | 83 | 262.5 | 345.5 | |
| Tazewell | 1938 | ---------- | ---------- | 91.5 | 439.5 | 531 | |
| Washington | 1937 | 36 | 271 | 263.8 | ---------- | 570.8 | 1,957.8 |
| Grand Totals | ---------- | 352.5 | 3,093.7 | 3,256.3 | 3,467.5 | ---------- | 10,170.0 |

see River watershed. In addition, parts of 9 other counties have been surveyed to the extent of some 1,728 additional square miles. The total area surveyed, therefore, is 10,170 square miles, or almost one-fourth of the entire watershed. This amounts to approximately 45 per cent of the area requiring survey.

The numbers of counties and special areas, and the square miles of each, covered in regular surveys in the seven States are shown by fiscal years to June 30, 1938, in Table 5. The proportion of the work done in each State is determined by the proportion of the State lying within the Tennessee Valley watershed and also by the extent to which modern surveys already had been conducted within these portions.

### D. WATER-RUNOFF AND SOIL-MOVEMENT STUDIES

The nature and scope of these cooperative studies, undertaken by the Tennessee and Virginia Experiment Stations, have been described in the earlier discussion of Cooperative Programs Developed (p. 19). The Virginia studies were not begun until 1936 and those in Tennessee only in 1937, and therefore have not continued long enough to provide many data.

At the Virginia Station, the results thus far obtained have definitely established the fact that considerable quantities of water and small amounts of soil are lost annually from average sods on the Dunmore type of soil where no fertilization or other conservation measures have been applied. These results indicate that the application of 200 pounds of triple superphosphate per acre reduces the amount of runoff approximately 40 per cent. This is because the growth of pasture grasses and other plants is greatly increased by the phosphate, thereby producing a thick sod that holds the water and surface soil.

At the Tennessee Station some indicative results have been obtained. Six parallel plots, each 120 by 18.15 feet and containing one-twentieth of an acre, were established on a 10-percent slope on Cumberland loam soil. In 1938, these plots were variously strip-cropped, grassed, fallowed, and row-cropped, in different periods. The quantities of runoff water and eroded soil were caught and measured and the results are given in Table 6. These short-period data must be regarded as indicative but not conclusive.

The protective effect of grass is well illustrated in Sections B and C of the Tennessee Station portion of the Table, which shows high runoff but relatively little soil loss under grass. If the lowest transverse strips on plots 1, 2, and 3 had been in grass instead of fallow, it is probable that much moving soil would have been held in the grass and not lost entirely. In the total downpour of 0.83 inches on the afternoon of April 18, (Section C), 0.78 of an inch fell in 8 minutes, or at the rate of 5.85 inches per hour.

At the Greenville Station, the rains in period A were mostly light showers, the heaviest precipitation in 24 hours being 0.81 inches. In period B, with a total but little larger, there were

TABLE 6.—*Water runoff and soil losses from plots, variously treated, on 10 percent slope, at the Tennessee Experiment Station, Knoxville, and the Greenville Tobacco Station, in stated periods in 1938, under the conditions of precipitation given in table and text.*

| Plot No. | Station, Precipitation Period, and Plot Treatments | Water Runoff | | Soil Losses Per Acre Tons |
|---|---|---|---|---|
| | | Inches | Percent | |
| | TENNESSEE EXPERIMENT STATION: Cumberland Loam | | | |
| | A. Jan. 1 to March 15. Precipitation 10.93 inches: | | | |
| 1 | 6 transverse strips, alternate grass and fallow | 0.39 | 3.6 | 0.98 |
| 2 | 4 transverse strips, alternate grass and fallow | 0.29 | 2.7 | 0.83 |
| 3 | 2 transverse strips, alternate grass and fallow | 0.26 | 2.4 | 0.55 |
| 4 | All grass | 0.18 | 1.6 | 0.07 |
| 5 | All fallow, smooth surface | 1.72 | 15.7 | 7.87 |
| 6 | All fallow, ridged surface | 0.47 | 4.3 | 1.37 |
| | B. March 16 to July 5. Precipitation 23.33 inches: | | | |
| 1 | 6 transverse strips, alternate grass and potatoes | 5.28 | 22.6 | 14.49 |
| 2 | 4 transverse strips, alternate grass and potatoes | 4.62 | 19.8 | 19.09 |
| 3 | 2 transverse strips, alternate grass and potatoes | 4.15 | 17.8 | 15.59 |
| 4 | All grass | 3.59 | 15.4 | 0.46 |
| 5 | All cultivated potatoes | 6.85 | 29.4 | 43.40 |
| 6 | All cultivated potatoes | 5.76 | 24.7 | 39.02 |
| | C. Afternoon of April 18. Precipitation 0.83 inches: | | | |
| 1 | 6 transverse strips, alternate grass and potatoes | 0.42 | 50.6 | 4.26 |
| 2 | 4 transverse strips, alternate grass and potatoes | 0.39 | 47.0 | 5.42 |
| 3 | 2 transverse strips, alternate grass and potatoes | 0.41 | 49.4 | 4.42 |
| 4 | All grass | 0.30 | 36.1 | 0.06 |
| 5 | All cultivated potatoes | 0.52 | 62.7 | 7.29 |
| 6 | All cultivated potatoes | 0.41 | 49.4 | 6.50 |
| | GREENVILLE TOBACCO STATION: Talbot Silt Loam | | | |
| | A. March 24 to July 2. Precipitation 9.27 inches: | | | |
| 1 | Corn | ---------- | ---------- | 0.34 |
| 2 | Oats and lespedeza | ---------- | ---------- | 0.49 |
| 3 | Lespedeza | ---------- | ---------- | 0.47 |
| 4 | Oats | ---------- | ---------- | 0.44 |
| 5 | Grass, with N and K | ---------- | ---------- | 1.35 |
| 6 | Grass, with N, P, and K | ---------- | ---------- | 1.73 |
| | B. July 3 to August 31. Precipitation 10.22 inches: | | | |
| 1 | Corn | ---------- | ---------- | 2.71 |
| 2 | Lespedeza after oats | ---------- | ---------- | 0.67 |
| 3 | Lespedeza | ---------- | ---------- | 0.07 |
| 4 | Crimson clover (new seedling) | ---------- | ---------- | 12.25 |
| 5 | Grass with N and K | ---------- | ---------- | 0.31 |
| 6 | Grass with N, P, and K | ---------- | ---------- | 1.18 |

three 24-hour periods in which the precipitation was 1.14, 1.23, and 1.55 inches, respectively.

### E. TERRACING COSTS

Mechanical structures, such as terraces and sidehill ridges, are recognized as useful in the prevention of water runoff and soil erosion. Through the cooperation of the Valley-States Land-Grant Colleges with the Authority, these methods are being applied to large areas of land in the Tennessee River watershed. This is done as a practical aid to watershed protection and in connection with the fertilizer treatments and cropping readjustments, as discussed earlier in the section on Cooperative Programs Developed (p. 20).

Terracing is done both by large power outfits and by ordinary farm equipment. Some of the large outfits are owned by associations of farmers or by counties and some are leased from equipment companies. In all cases, the estimated cost of the work is borne by the farmer owning the land. The actual costs of

these mechanical methods of land protection therefore are of much concern to the Colleges and the farmers.

In 1935, the Alabama Station, in cooperation with the TVA, began a 3-year study of the cost of terracing farm land in the Valley States with cooperatively-owned heavy power equipment. Detailed studies were made on cost records on 7,332 miles of terraces constructed in 42 counties of the several States. The findings are summarized below.

Slope of land is the dominant factor influencing acre cost of terracing, which increased rather uniformly from about two dollars per acre on 2 per cent slopes to more than eight dollars per acre on 15 per cent slopes. The average cost on all slopes was about $31 per mile of terrace. Costs increased with heaviness of soil texture, and with increased extent of both sheet and gully erosion. Operating costs, of which labor was the major item, constituted 52.8 per cent of the total cost of terracing and the remaining 47.2 per cent represented amortization of equipment costs. The data indicate that such cooperatively-owned power equipment would have to operate for 8,000 to 10,000 hours in order to be self-liquidating when a charge of $3 per hour is made.

### F. FARM MANAGEMENT STUDIES

The studies of farm management problems, entailed by the land-use adjustment program, were described earlier under the Cooperative Programs Developed. The Virginia Station started a study of the beef-cattle enterprise in Russell County, in 1935. Initial records were made on a total of 506 farms to determine the factors affecting the carrying capacity of pastures and the adjustments possible to prevent erosion, maintain fertility, and increase income.

On the 226 farms that kept beef cattle, the average labor income of the operator was –$68.00, whereas on the remainder of the farms, which did not keep beef cattle, the average labor income of the operator was –$125.00 per farm. Moreover, the soil under pastures suffered much less from erosion than did the soil under cultivated crops. Russell County is very hilly and livestock raising is the best farming enterprise for the area even though it temporarily is unprofitable.

### G. PROCESSING AND MARKETING FARM PRODUCTS

The Tennessee, Georgia, and Mississippi Experiment Stations have cooperated with the Authority in two related phases of the improvement of agricultural industries. The first covers new or improved methods of processing and marketing farm products. The second covers the development of special types of farm machinery. These improvements are designed to permit the better utilization of the Valley lands in conjunction with the application of phosphates and with other needed readjustments of the crop and farming systems in a water-control program. The conditions and problems have been presented earlier in the section on Cooperative Programs Developed.

In connection with the readjustment in farm programs necessary to the protection of the Tennessee Valley watershed, it is recognized that the most difficult barriers are economic, in that new farming systems must be worked out which maintain or increase farm income, at the same time enabling the farmer to reduce his acreage of erosion-permitting row crops. Increased income is essential if farmers are to be able to adopt soil-conserving practices. Another barrier to the adoption of soil-conserving practices lies in the lack of suitable farm machinery for the small and low-income hill farm.

Some of the engineering phases of these problems have been studied by the Engineering Experiment Stations, or Colleges of Engineering, of the Land-Grant Colleges concerned, under separate contracts with the Authority. This three-way attack on problems of mutual interest undoubtedly has helped to further the objectives of each of the agencies participating and to speed up the production of results for the benefit of the farmer.

(1) *Hay Curing.* The emphasis being placed on the increase of hay crops for soil protection, and the increased production obtained by better fertilization, render more acute the need for improved methods of curing, especially in wet seasons. The use of supplementary ventilation by forcing air through stored hay, with the air in some cases heated by a solar heater, is being studied at the Tennessee Station. The trials of this equipment have been very encouraging.

(2) *Tobacco Curing.* The need for close control of the heat and moisture in tobacco barns has led to the study of the use of air-circulating equipment with indications of favorable results at the Tennessee Station.

(3) *Sweet Potato Storage.* Electrical heat to control temperature and humidity and thus reduce the loss in sweet potato storage, being tested by the Tennessee Station, seems to have decided advantages over other methods in common use.

(4) *Sorghum Sirup Processing.* Sorghum sirup is an important product in the Valley, but is made in small home plants without uniformity of method or product. The Tennessee and Georgia Stations, during several seasons, have studied not only the improvement of methods in these home plants, but also the assembling, treating, and standardizing of the product of community plants to produce a higher quality. These studies have been extended to cover marketing tests of the improved product. Tests of sorghum varieties also have been conducted. These two Stations are continuing the work.

(5) *Freezing and Marketing of Fruits and Vegetables.* Extensive experiments have been conducted, mostly by the Department of Engineering of the University of Tennessee, in the development of methods and equipment for the quick freezing of fruits, vegetables, and other farm products, and the determination of their adaptation to the market. These projects have a

definite relation to the better protection and utilization of land, the use of electric power, and the increase of farm income.

Consumers usually have a preference for the fresh product as against the canned or dried product. The short season for fresh fruits and vegetables, and similar farm products, usually results in a glut on the available market in that short period. By suitable methods of freezing the fresh product, its market period can be expanded and its geographical range increased. The experiments at the University of Tennessee have attained a fairly large scale and the results have attracted the favorable attention of commercial handlers of these products.

The Tennessee Station, in cooperation with the Authority, has carried on an extensive survey of the market for such frozen products. The results of these studies are presented in Bulletin 161 of the Station.* This Station also is working toward developing varieties of berries especially suited to quick freezing.

The Georgia Station has been engaged in a microscopical examination of such fruit and vegetable products to determine the relation of the treatments to their texture, structure, color, and eating quality. It has been determined previously that optimum temperatures for obtaining high quality are fairly definite for each product. Attempt also has been made to correlate the quality of the products with the kinds and rates of fertilizer used, particularly phosphorus, potash, and nitrogen.

(6) *Rapid Methods of Flax Processing and Spinning.* The Tennessee and the Georgia Stations have participated in fertilizer and growing tests of flax, particularly fiber varieties. The Georgia School of Technology, a part of the University System, has been conducting extensive tests of the possibility of quick methods of mechanical-chemical dewooding, degumming, and preparation of the fiber for spinning. It likewise has studied spinning on cotton systems, with and without cotton fiber, and also the utilization of the product in fabrics. The Tennessee Station fertilizer tests on flax were limited to the season of 1935. The Georgia Station took up variety, fertilizer, and field-growth studies in 1937, cooperating with the Georgia School of Technology on the engineering and textile side of the studies. Fabrics have been produced and subjected to use tests.

(7) *Cottonseed Processing.* The Mississippi Station has carried out a survey of manufacturing establishments which process oil-bearing seeds. The changing situation due to increased soybean production and other factors was analyzed as it affects the cotton economy and the position of cottonseed oil mills.

In addition to its own projects on cotton, the Tennessee Station, through the Cotton Institute of the University, has been in touch with research on increasing the value of the cotton crop by improved processing of its products. This Station has conducted feeding tests with the meal produced by the new cottonseed-

*Frozen-Pack Fruit Markets: Harry Carlton. Tennessee Agri. Exp. Station, Bul. 161:1-72, June, 1937.

cooking process developed by the Authority and the Tennessee Engineering Experiment Station. The purpose is to determine whether this process eliminates gossypol, thus making the meal safe for feeding to pigs.

### H. NEW AND IMPROVED EQUIPMENT

(1) *New Machines and Equipment.* The Tennessee Station has cooperated in the development of a lespedeza harvester needed by Valley farmers to carry out their share of the soil-conservation program. Other cooperative projects on which work is under way include seed scarifying, seed cleaning, a low-cost lime and fertilizer spreader, and machines for adding phosphoric acid or molasses to legume silage.

Other new farm tools such as a small plow and seeder for sowing small grain in lespedeza sod in the fall, and farm and community refrigeration and other equipment using electrical power, have been developed on the engineering side by the University of Tennessee Engineering Experiment Station and the Authority, and on the demonstration side by the Extension Services. The Agricultural Experiment Station has had only incidental contact with these studies, in observing the operation of the equipment.

(2) *Development of Rural Community Refrigeration.* The ability to place farm-killed meats in refrigeration promptly means a saving of valuable farm products, an improvement in the rural family dietary, and a decrease in the cash outlay necessary for food. The Tennessee Engineering Experiment Station in cooperation with the Authority has investigated the construction of low-cost and effective electric refrigeration units for rural communities. The Engineering Station has issued a bulletin giving detailed information on the installation and operation of these community coolers.*

The State Extension Services and Departments of Vocational Education, in cooperation with the Authority, have demonstrated rural community refrigeration in 11 districts in the Tennessee Valley area. Construction plans have been made available to any group desiring to build these units and are being used by rural groups in building their own refrigeration boxes. An educational film strip on community refrigeration has been prepared for showing both to extension workers and to farmer groups in order to stimulate further interest and provide further knowledge on this important subject.

## 4. RESULTS OF EXTENSION AND EDUCATIONAL ACTIVITIES

Five major activities in the field of agricultural extension education are conducted by some or all of the seven Valley-States Land-Grant Colleges in cooperation with the Tennessee Valley Authority. These are, respectively, (a) farm test-demonstrations with phosphates, (b) test-demonstrations of terracing equipment and procedures ,(c) relocation of displaced reservoir families, (d)

*Carpenter, E. L., and Mack Tucker. Farm and community refrigeration. Tenn. Engineering Experiment Station, Bul. 12. March, 1936.

agricultural training of reservoir-clearance employees, and (e) improvement of Authority-owned reservoir lands. The farm test-demonstrations are more extensive than all the other four activities combined. Some minor extension activities have developed from the Station investigations of processing farm products and developing new or improved machinery and equipment.

Because the results of educational programs are less tangible than those of research, they are more difficult to assemble and evaluate. Especially is it true that more years are required in order to produce measurable results in education than in experimentation. For example, it usually requires several to many years for any considerable numbers of farmers to become familiar with a newly demonstrated practice and to adopt it on their own farms.

With these limitations in mind, an effort is made to determine and set forth here some of the measurable results of these extension activities promoted in cooperation with the Authority.

### A. FARM TEST-DEMONSTRATIONS WITH PHOSPHATES

The farm test-demonstration program for the Tennessee River watershed was outlined earlier, under Cooperative Programs Developed. Such a program reasonably may be expected to produce a series of results, through a period of years. These results may be listed in the order of their immediacy.

First is water and soil conservation, brought about by better plant cover on lands suffering from water runoff and soil erosion. Second is better land-use adjustment, produced by shifting row crops from steeper to more level lands and by creating a better balance between the cash crops and the soil-conserving and water-conserving grasses and legumes in pasture and meadow. Third stands increased soil fertility created by the judicious use of phosphate, lime, and other fertilizers and soil amendments, and by nitrogen obtained from the air through legumes.

Fourth may be placed a better farm management organization arising from the land-use adjustment mentioned above and the ability to support more livestock because of more and/or better pasture and meadow. Fifth is the larger and more stable farm income which should result from the other conditions just listed. Sixth and last is the better standard of family living which should come from the better farm organization, more diversified production, and increased income.

All of these objectives, and perhaps others, are comprehended in the requirement of the TVA Act that these phosphate test-demonstrations be so conducted as to determine the effect and value of the phosphates and to measure accurately the economic return they produce.

Obviously these objectives cannot be achieved and these results produced on the individual farm in a matter of months or seasons, or even in a few years. It is a long-time job, measured in decades. Moreover, economic returns must be measured in terms of

the community and the entire area, as well as in terms of the participating farm and family.

Achievement always consists of a series of steps. Results usually comprise a series of factors. There are criterions of progress. Although the program was begun only four years ago, and on a large scale only three years ago, some of these criterions of progress may be set down. In order, these are: (1) numbers and acreage of the test-demonstration farms established; (2) quantities of concentrated phosphates and lime supplied and used; (3) increased acreages of soil-building and water-conserving crops and decreased acreages of cash and row crops; (4) stopping of new gully formation and gradual filling of old gullies; (5) increased numbers of livestock and poultry incident to land-use adjustments; and (6) increased farm income, either actual or relative to cash outgo.

Some of these results, such as the numbers and acreages of test-demonstration farms, the quantities of phosphate and lime used, and the increased acreages of conserving crops may be recorded and tabulated, year by year. Others may be measured more slowly and with more difficulty.

### (1) NUMBERS AND ACREAGE OF TEST-DEMONSTRATION FARMS

There are two classes of test-demonstration farms, as described earlier under Cooperative Programs Developed. These are farm-unit test-demonstrations and area test-demonstrations, respectively.

(a) *Farm-Unit Test-Demonstrations.* In the case of the farm-unit farms, the entire farm, including the farm family, is regarded as an operating unit in planning the program and determining the results. One such farm is established in any given community and a definite program of land-use adjustment and phosphate fertilization in the interest of water and soil control and use is agreed upon, for at least a five-year period. Operating and business records are kept. The other farmers in the community study the practices on this farm and appraise the results, adopting on their own farms such as seem applicable.

In Table 7 are shown the numbers and acreages of these farm-unit test-demonstration farms, by fiscal years from 1935 to 1938, in the Valley counties and the non-Valley counties of the seven Valley States. These data show that there were 6,348 such farms, containing 1,094,719 acres, in 122 Valley counties on June 30, 1938. In addition, there were 3,483 of these farms, containing 808,432 acres, located in 205 non-Valley counties in the same seven States. The grand total for the 327 counties was 9,831 farms, with 1,903,151 acres.

(b) *Area Test-Demonstrations.* The area test-demonstration farms are projects designed to enlist the active participation of all the farms of an area, such as a community or small watershed, in some degree of water conservation and the control of soil movement. Land use and cropping practices are readjusted as needed to achieve these results and phosphates are applied to aid in ob-

TABLE 7.—*Farm-Unit test-demonstration farms using TVA phosphate (triple superphosphate or calcium metaphosphate) showing, for Valley and Non-Valley counties in the seven Valley States, the cumulative numbers and acreages by fiscal years from 1935 to 1938, inclusive.*

| STATE AND COUNTY GROUPS | Number of Counties in 1938 | 1934-35 | | 1935-36 | | 1936-37 | | 1937-38 | |
|---|---|---|---|---|---|---|---|---|---|
| | | Number of Farms | Acres in Farms | Number of Farms | Acres in Farms | Number of Farms | Acres in Farms | Number of Farms | Acres in Farms |
| In Valley Counties: | | | | | | | | | |
| Alabama | 15 | ---------- | ---------- | 161 | 45,231 | 183 | 50,346 | 196 | 52,726 |
| Georgia | 9 | 186 | 42,680 | 393 | 80,523 | 424 | 86,237 | 432 | 87,031 |
| Kentucky | 7 | ---------- | ---------- | 277 | 51,125 | 341 | 62,898 | 368 | 65,842 |
| Mississippi | 4 | 17 | 2,450 | 138 | 22,678 | 152 | 25,423 | 151 | 25,343 |
| North Carolina | 15 | 148 | 22,583 | 957 | 120,338 | 1,082 | 137,590 | 1,092 | 138,876 |
| Tennessee | 61 | 28 | 1,184 | 3,219 | 545,740 | 3,686 | 630,851 | 3,692 | 631,597 |
| Virginia | 11 | 169 | 51,814 | 354 | 86,109 | 411 | 92,233 | 417 | 93,304 |
| Totals | 122 | 548 | 120,711 | 5,499 | 951,744 | 6,279 | 1,085,578 | 6,348 | 1,094,719 |
| In Non-Valley Counties: | | | | | | | | | |
| Alabama | 28 | ---------- | ---------- | 26 | 10,661 | 121 | 51,951 | 183 | 74,644 |
| Georgia | 31 | ---------- | ---------- | 294 | 75,683 | 446 | 116,808 | 458 | 118,563 |
| Kentucky | 42 | ---------- | ---------- | 658 | 116,677 | 1,080 | 194,616 | 1,102 | 197,972 |
| Mississippi | 22 | ---------- | ---------- | 283 | 83,555 | 392 | 120,284 | 450 | 135,667 |
| North Carolina | 47 | ---------- | ---------- | 732 | 133,178 | 800 | 150,334 | 802 | 150,708 |
| Tennessee | 2 | ---------- | ---------- | 24 | 4,364 | 24 | 4,364 | 25 | 4,473 |
| Virginia | 33 | ---------- | ---------- | 179 | 55,040 | 365 | 104,208 | 463 | 126,405 |
| Totals | 205 | ---------- | ---------- | 2,196 | 479,158 | 3,228 | 742,565 | 3,483 | 808,432 |
| Grand Totals | 327 | 548 | 120,711 | 7,695 | 1,430,902 | 9,507 | 1,828,143 | 9,831 | 1,903,151 |

taining the necessary vegetative cover. This type of test-demonstration is confined wholly within the Tennessee River watershed. Numbers and acreages of these farms, cumulative by fiscal years, are shown in Table 8. These 11,832 area farms contain 1,564,516 acres.

(c) *Combined Farm-Unit and Area Test-Demonstrations.* The combined numbers and acreages of all farm-unit and area test-demonstration farms in the seven Valley States, cumulative by fiscal years from 1935 to 1938, inclusive, are shown in Table 9. The data are presented for one group of 122 counties lying wholly or mostly within the Tennessee Valley watershed and for a second group of 205 counties lying wholly or chiefly without the area. The participating farms number 21,663 and contain 3,467,667 acres or about 5,775 square miles. They are located in 327 different counties, or more than one-tenth of all the counties in the United States.

Of these 21,663 farms, 9,831 are farm-unit test-demonstration farms and 11,832 are in area test-demonstrations. Of the farm-unit farms 6,348 are in the Valley counties and 3,483 are in non-Valley counties. All of the 11,832 area farms are in the Valley counties, making a total of 18,180 farms, with somewhat more than 2,659,000 acres, in the 122 Valley counties. As all farms of the Valley watershed contain a total of about 17,850,000 acres, approximately 14.8 per cent of the Valley area is protected by the practices on these test-demonstration farms.

### (2) AUTHORITY PHOSPHATES FOR TEST-DEMONSTRATIONS

The Tennessee Valley Authority has furnished its experimental phosphate fertilizers for this test-demonstration program because it is required to determine their efficiency and also because promoting adequate plant cover by fertilization aids the control of water and soil movement on the farms and flood control and reservoir protection in the valleys. The distribution of these phosphates to Valley and non-Valley counties in the seven States, by fiscal years from 1935 to 1938, with 4-year totals, is shown in Table 10.

Of the 63,065 tons furnished, 50,302 tons have gone to the farm-unit and area test-demonstrations in 122 Valley counties and 12,763 tons to the farm-unit test-demonstrations in 205 non-Valley counties of the seven States. Nearly all of this tonnage has been triple superphosphate, originally containing about 43 per cent $P_2O_5$ but recently averaging about 45 per cent. In 1938, some 256 tons of calcium metaphosphate, containing about 65 per cent of $P_2O_5$, were distributed and are included in the totals.

This test-demonstration program has acquainted many thousands of farmers with the use of concentrated phosphatic fertilizers. Partly as a result of this extension education, farmers in 4 Valley States, Kentucky, North Carolina, Tennessee, and Virginia, have obtained more than 73,000 additional tons of concentrated phosphates through the Agricultural Adjustment Administration.

TABLE 8.—*Area test-demonstration farms using TVA phosphate (triple superphosphate) showing, for Valley counties in the seven Valley States, the cumulative numbers and acreages by fiscal years from 1935 to 1938, inclusive.*

| STATE AND COUNTY GROUPS | Number of Counties in 1938 | 1934-35 | | 1935-36 | | 1936-37 | | 1937-38 | |
|---|---|---|---|---|---|---|---|---|---|
| | | Number of Farms | Acres in Farms | Number of Farms | Acres in Farms | Number of Farms | Acres in Farms | Number of Farms | Acres in Farms |
| In Valley Counties: | | | | | | | | | |
| Alabama | 15 | ---------- | ---------- | 1,290 | 252,492 | 2,483 | 435,915 | 2,793 | 470,832 |
| Georgia | 9 | 8 | 791 | 873 | 103,703 | 987 | 115,572 | 1,030 | 121,827 |
| Kentucky | 1 | ---------- | ---------- | ---------- | ---------- | 28 | 2,633 | 50 | 4,796 |
| Mississippi | 4 | ---------- | ---------- | 634 | 48,968 | 1,070 | 101,616 | 1,073 | 101,796 |
| North Carolina | 10 | ---------- | ---------- | 226 | 16,538 | 395 | 31,026 | 419 | 32,249 |
| Tennessee | 45 | ---------- | ---------- | 430 | 57,301 | 2,627 | 268,014 | 2,673 | 272,186 |
| Virginia | 11 | ---------- | ---------- | 1,804 | 320,165 | 3,431 | 513,373 | 3,794 | 560,830 |
| Grand Totals | 95 | 8 | 791 | 5,257 | 799,167 | 11,021 | 1,468,149 | 11,832 | 1,564,516 |

TABLE 9.—*All test-demonstration farms (unit and area) using TVA phosphates (triple superphosphate or calcium metaphosphate), showing for Valley and Non-Valley counties in the seven Valley States the cumulative numbers and acres by fiscal years from 1935 to 1938, inclusive.*

| STATES AND COUNTY GROUPS | Number of Counties in 1938 | 1934-35 | | 1935-36 | | 1936-37 | | 1937-38 | |
|---|---|---|---|---|---|---|---|---|---|
| | | Number of Farms | Acres in Farms | Number of Farms | Acres in Farms | Number of Farms | Acres in Farms | Number of Farms | Acres in Farms |
| In Valley Counties: | | | | | | | | | |
| Alabama | 15 | ---------- | ---------- | 1,451 | 297,723 | 2,666 | 486,261 | 2,989 | 523,558 |
| Georgia | 9 | 194 | 43,471 | 1,266 | 184,226 | 1,411 | 201,809 | 1,462 | 208,858 |
| Kentucky | 7 | ---------- | ---------- | 277 | 51,125 | 369 | 65,531 | 418 | 70,638 |
| Mississippi | 4 | 17 | 2,450 | 772 | 71,646 | 1,222 | 127,039 | 1,224 | 127,139 |
| North Carolina | 15 | 148 | 22,583 | 1,183 | 136,876 | 1,477 | 168,616 | 1,511 | 171,125 |
| Tennessee | 61 | 28 | 1,184 | 3,649 | 603,041 | 6,313 | 898,865 | 6,365 | 903,783 |
| Virginia | 11 | 169 | 51,814 | 2,158 | 406,274 | 3,842 | 605,606 | 4,211 | 654,134 |
| Totals | 122 | 556 | 121,502 | 10,756 | 1,750,911 | 17,300 | 2,553,727 | 18,180 | 2,659,235 |
| In Non-Valley Counties: | | | | | | | | | |
| Alabama | 28 | ---------- | ---------- | 26 | 10,661 | 121 | 51,951 | 183 | 74,644 |
| Georgia | 31 | ---------- | ---------- | 294 | 75,683 | 446 | 116,808 | 458 | 118,563 |
| Kentucky | 42 | ---------- | ---------- | 658 | 116,677 | 1,080 | 194,616 | 1,102 | 197,972 |
| Mississippi | 22 | ---------- | ---------- | 283 | 83,555 | 392 | 120,284 | 450 | 135,667 |
| North Carolina | 47 | ---------- | ---------- | 732 | 133,178 | 800 | 150,334 | 802 | 150,708 |
| Tennessee | 2 | ---------- | ---------- | 24 | 4,364 | 24 | 4,364 | 25 | 4,473 |
| Virginia | 33 | ---------- | ---------- | 179 | 55,040 | 365 | 104,208 | 463 | 126,405 |
| Totals | 205 | ---------- | ---------- | 2,196 | 479,158 | 3,228 | 742,565 | 3,483 | 808,432 |
| Grand Totals | 327 | 556 | 121,502 | 12,952 | 2,230,069 | 20,528 | 3,296,292 | 21,663 | 3,467,667 |

TABLE 10.—*Distribution of TVA phosphates (triple superphosphate and calcium metaphosphate) in tons, to Valley and non-Valley counties, in the seven Valley States, by fiscal years from 1935 to 1938, inclusive, with 4-year totals.*

| STATES AND COUNTY GROUPS | 1935 | 1936 | 1937 | 1938 | 4-Year Totals |
|---|---|---|---|---|---|
| To Valley Counties: | | | | | |
| Alabama | ---------- | 2,016.65 | 1,794.75 | 1,347.55 | 5,158.95 |
| Georgia | 630.00 | 1,545.70 | 809.55 | 591.30 | 3,576.55 |
| Kentucky | ---------- | 440.80 | 280.85 | 372.90 | 1,094.55 |
| Mississippi | 40.30 | 975.20 | 760.30 | 235.00 | 2,010.80 |
| North Carolina | 514.40 | 2,604.60 | 1,153.20 | 742.70 | 5,104.90 |
| Tennessee | 95.95 | 10,832.85 | 7,065.10 | 3,231.80 | 21,225.70 |
| Virginia | 766.80 | 5,433.10 | 4,450.55 | 1,569.85 | 12,220.30 |
| Totals | 2,047.45 | 23,848.90 | 16,314.30 | 8,091.10 | 50,301.75 |
| To Non-Valley Counties: | | | | | |
| Alabama | ---------- | 90.75 | 553.30 | 496.80 | 1,140.85 |
| Georgia | ---------- | 654.65 | 749.90 | 562.15 | 1,966.70 |
| Kentucky | ---------- | 586.05 | 683.75 | 760.10 | 2,029.90 |
| Mississippi | ---------- | 1,149.40 | 688.70 | 693.25 | 2,531.35 |
| North Carolina | ---------- | 1,580.20 | 536.95 | 267.45 | 2,384.60 |
| Tennessee | ---------- | 56.25 | ---------- | 26.00 | 82.25 |
| Virginia | ---------- | 420.00 | 889.90 | 1,317.45 | 2,627.35 |
| Totals | ---------- | 4,537.30 | 4,102.50 | 4,123.20 | 12,763.00 |
| Grand Totals | 2,047.45 | 28,386.20 | 20,416.80 | 12,214.30* | 63,064.75* |

*Of these totals, 255.50 tons are calcium metaphosphate.

## (3) IMPROVED PRACTICES ON TEST-DEMONSTRATION FARMS

The purpose of the test-demonstration program, as set forth earlier, is to test and demonstrate the effect of the experimental concentrated phosphates in the control of water and soil movement on farm, in the building of soil fertility, and in the increase of farm income and family living. The county agricultural agents and district supervisors for the counties in which the program is operating are unanimous in their belief that these objectives are being achieved.

As evidence of this achievement, they cite (a) the steady increase in acreage protected by terraces, (b) the growing acreage of water-holding and soil-improving grasses and legumes, (c) the accompanying increase in livestock units to make use of these grazing and feeding crops, (d) the better quality of the livestock produced and especially of the breeding stock purchased, (e) the shift of erosion-permitting row crops to the more level lands, (f) the tendency toward a decreased acreage of row crops, especially cotton, on the test-demonstration farms, (g) the increased yields of grain and row crops following the fertilized and limed grasses and legumes, (h) the tendency toward an increased labor income on these farms, and (i) the improvements in farm homes and in farm-family living consequent to the new program.

Last but by no means least, they point out the increased willingness and desire of the farmers to cooperate with each other and with State and Federal agencies in this and other improvement programs. The county associations and community groups of farmers are developing larger and more effective responsibilities in the test-demonstration program. They also are ex-

tending their activities to cover other cooperative action and improvement programs in their respective communities and counties.

It is not yet possible to present any large volume of statistical data in support of these beliefs of the extension agents. The reasons for this condition are several but simple. In the first place, the program is only four years old. Relatively few of these farms were established in the first year and only about half of the total by the second year. The great majority of them have been in operation, therefore, only three years or less. The data for 1936 have been assembled and studied. The reports for 1937 are in but the analysis has not been completed in all cases. The reports for 1938 will not be available for some months.

Then, too, there has been some mortality among the demonstrators who started in the earlier years. This is natural. The program was in a tentative condition and not well understood by either the farmers or the extension workers and supervisors. Some demonstrators dropped out when they fully realized the extensive records required. Others were dropped for omitting some vital part of the program. Still others were lost because of change in farm owner or tenant, or because of illness or other family trouble. The number of demonstrations from which long-time records might otherwise be available now has been diminished accordingly.

Many records of achievement on individual farms, among the more than 21,000 operating in 1938, could be given here. Such presentation would unduly enlarge this report and the records also would be open to the suspicion of representing much better than average accomplishments. Data are given below on some representative groups of test-demonstration farms, in different States, from which comparable data have been assembled and analyzed.

The test-demonstration program is conducted in about the same way in all seven States. It has two main divisions, however, the farm-unit and the area farms, and there are several criterions of progress for each division. Lack of space prevents summarizing all results from all States. Therefore, in the pages which follow, the results of different kinds of activities will be summarized for each of the different States, so far as possible. In that way, a picture of all kinds of results can be given.

*Alabama Results.* Prior to 1935, the use of lespedeza or winter legumes was at a low ebb in the Valley counties of Alabama. Lack of phosphate was known to be an important limiting factor. Pastures were regarded largely as waste land and fertilizing them was unheard of. Since the organization of the cooperative test-demonstration program, this situation has been changed rapidly.

Some of the results of the demonstration program begun in 1935 are shown in Table 11. The figures given are for 11 of the 15 counties of the Tennessee River watershed of Alabama but they represent the efforts of more farmers than those on the demonstration farms. However, the increases from 1935 onward

chiefly are the results of the test-demonstration program. The acreages of legumes sown and tons of legume seed saved include cooperative farmer activities on some reservoir lands owned by the Authority. These are reported more fully later.

TABLE 11.—*Acres of legumes sown, tons of their seed harvested, and tons of experimental phosphates used on cover crops in 11 Valley counties of Alabama, in the four years, 1934-1937.*

| ITEMS OF ACHIEVEMENT | Calendar Years | | | |
|---|---|---|---|---|
| | 1934 | 1935 | 1936 | 1937 |
| Legumes Sown, Acres: | | | | |
| Lespedeza | 10,720 | 99,982 | 149,780 | 141,901 |
| Winter Legumes | 53,320 | 60,550 | 90,406 | 126,520 |
| Legume Seed Harvested (tons): | | | | |
| Lespedeza | 50 | 300 | 296 | 1,012 |
| Crimson Clover (mostly) | ---------- | ---------- | ---------- | 307 |
| Pastures (1,343 new) Sown, Acres | ---------- | ---------- | ---------- | 6,984 |
| Phosphates on Cover Crops, Tons | 56 | 2,908 | 6,295 | 10,363 |

On 166 farm-unit test-demonstration farms outside the Valley area of Alabama, more than 1,360 tons of experimental phosphates have been applied in the last year or two. By this means more effective control of water and soil movement has been achieved on 25,310 acres of pasture and 14,341 acres of other cover crops.

*Georgia Results.* For Georgia there are presented certain progress data for a group of 76 test-demonstration farms in the 9 Valley counties, progress data from the Bell Creek area test-demonstration, and a few items showing general progress in the counties where this intensive program is carried on.

In Table 12 are shown data on shifts of crop acreage on 76 farm-unit test-demonstration farms in the four calendar years

TABLE 12.—*Percentage of crop land in row crops and in all soil-protecting and soil-improving crops on 76 farm-unit test-demonstration farms, grouped according to average acreage, in the 9 Tennessee Valley counties of northern Georgia, from 1934 to 1937, inclusive, with the 4-year shift in acres per 100 so used.*

| AVERAGE SIZE OF FARMS ACRES | Number of Farms | Percentage by Calendar Years | | | | 4-Year Change in Acres Per 100 |
|---|---|---|---|---|---|---|
| | | 1934 | 1935 | 1936 | 1937 | |
| | | Row Crops | | | | |
| 50.7 | 8 | 61.2 | 51.0 | 45.7 | 44.8 | −16.4 |
| 109.8 | 21 | 50.2 | 47.9 | 36.0 | 39.6 | −10.6 |
| 189.4 | 25 | 45.3 | 44.4 | 39.7 | 42.2 | −3.1 |
| 258.8 | 7 | 51.9 | 52.3 | 45.2 | 45.2 | −6.7 |
| 320.7 | 7 | 58.1 | 48.4 | 35.3 | 45.8 | −12.3 |
| 662.7 | 8 | 35.8 | 33.5 | 27.4 | 31.2 | −4.6 |
| | | Soil-Holding and Soil-Building Crops | | | | |
| 50.7 | 8 | 38.0 | 55.5 | 63.6 | 80.4 | 42.4 |
| 109.8 | 21 | 38.4 | 48.5 | 64.8 | 76.8 | 38.4 |
| 189.4 | 25 | 46.7 | 39.5 | 55.8 | 69.5 | 22.8 |
| 258.8 | 7 | 34.0 | 39.4 | 72.2 | 65.4 | 21.4 |
| 320.7 | 7 | 14.9 | 28.5 | 41.9 | 48.5 | 33.6 |
| 662.7 | 8 | 29.5 | 46.0 | 62.2 | 63.7 | 34.2 |

from 1934 to 1937. The acreages for 1934 were taken from a farm-management survey made in 1935. Data for the later years were taken from operating records kept by the test-demonstration farmers. These farms are arranged in six groups, in order of increasing average size. None of the farms changed in size during the four years.

The Table contains data for two classes of crops. First are shown the acreages of erosion-permitting row crops. Then are given the acreages of all soil- and water-holding and/or soil-building crops. These include small grains, hays, and cover crops, mostly legumes. It will be noted that there has been a decrease in row crops and a steady increase in protecting crops. By far the greater part of the increase has been in cover crops as compared with grain and hay, the latter actually decreasing in some farm groups. The acreages of protecting crops include all double-cropped acres.

There are 13 area test-demonstrations in the 9 Valley counties of northern Georgia. The Bell Creek area, a mountain cove of rough topography situated on the North Carolina line in Towns County, may be taken as an illustration. The area contains 4,043 acres (including woodland) in farms and 78 farmers, mostly owners, of whom 77 are cooperating in the test-demonstration program and 74 have used phosphate and lime. Terracing has been completed on all of the 78 farms. The 78 families contain 452 persons or one person for each 5.8 acres of open land.

At the beginning of the demonstration, the land in the area was classified into three groups: (1), good bottom land, not eroding under normal cultivation; (2), good upland, but eroding under normal cultivation; and (3), badly eroded upland no longer suitable for cropping. After the crop-shift, crop-fertilization, and terracing programs had been under way for two years the land was reclassified. The results, with other land-use data, are given in Table 13. To any one familiar with the area, these results are truly remarkable.

TABLE 13.—*Progress made by all or some of the 78 farmers in the Bell Creek test-demonstration area, Towns County, Georgia, in the two-year period, 1936 to 1937.*

| ITEMS OF PROGRESS | 1935 | 1937 |
|---|---|---|
| Land Classification, Acres: | | |
| 1. Good bottomland, not eroding | 334.5 | 334.5 |
| 2. Upland, suitable for cultivation | 1,415.5 | 1,838.5 |
| 3. Upland, badly eroded | 878.0 | 455.0 |
| Crops (Soil- and Water-Holding), Acres: | | |
| Pasture | 607.0 | 731.0 |
| Lespedeza | 10.0 | 933.5 |
| Crimson Clover | 0 | 124.0 |
| Terracing: | | |
| Trained terrace builders | 0 | 34 |
| Terrace drags | 0 | 17 |
| Land terraced, acres | 30.0 | 1,210.0 |
| Farm homes improved in periods, 22. | | |

Some interesting developments have taken place in these 9 Valley counties as a whole, since the test-demonstration program started. No one will claim that the program is the sole cause of these changes but it is significant that they have taken place much more rapidly in those counties where the test-demonstrations are in progress. For example, the numbers of purebred jacks, beef bulls, and dairy bulls have more than doubled in these 9 counties between 1935 and 1937. There also have been large increases in the numbers of purebred breeding hogs, heifers, and mares.

TABLE 14.—*Data on acreages and pounds of seed saved of certain annual legumes in the total area of 9 Valley counties in Georgia in the calendar years 1935, 1936, and 1937.*

| ANNUAL LEGUMES INVOLVED | 1935 | 1936 | 1937 |
|---|---|---|---|
| Legumes Sown (Acres): | | | |
| Crimson Clover | 1,237 | 3,795 | 9,475 |
| Vetch | 814 | 1,165 | 1,470 |
| Austrian Winter Pea | 570 | 685 | 835 |
| Legume Seed Saved (Pounds): | | | |
| Crimson Clover | 8,500 | 16,050 | 75,800 |
| Lespedeza | 5,800 | 88,200 | 102,000 |

The acreages of certain annual legumes sown, and the pounds of seed harvested from two legumes, for the whole area of these 9 counties, are shown in Table 14. Such quantities of seed saved speak well for increased acreages of these soil-improving crops in 1938.

*Kentucky Results.* For Kentucky are shown, in Tables 15 and 16, the effects produced by lime, by phosphate, and by both to-

TABLE 15.—*Effect of phosphate and other treatments on yields of grain crops in the seven Valley counties of Kentucky in 1936 and 1937.*

| CROPS, COUNTIES, AND YEARS | Total Number of | | Yields From Treatments Named (Bu.) | | | |
|---|---|---|---|---|---|---|
| | Fields | Acres | None | Lime | Phosphate | Phosphate and Lime |
| Wheat: | | | | | | |
| Calloway, 1937 | 80 | 814 | 6.2 | 8.5 | 12.1 | 17.5 |
| Graves, 1936 | 24 | 355 | 7.7 | 10.4 | 14.1 | 18.6 |
| 1937 | 47 | 656 | 9.3 | 13.2 | 15.5 | 19.8 |
| Livingston, 1937 | 14 | 182 | 12.0 | 14.0 | 18.0 | 19.5 |
| Lyon, 1937 | 6 | 80 | 4.0 | 4.5 | 8.2 | 10.6 |
| Marshall, 1936 | 16 | 142 | 7.9 | 8.3 | 10.9 | 11.7 |
| 1937 | 18 | 176 | 8.4 | 8.8 | 12.8 | 16.3 |
| McCracken, 1937 | 12 | 175 | 11.6 | 14.5 | 16.5 | 19.0 |
| Trigg, 1936 | 45 | 773 | 7.3 | 9.0 | 11.6 | 15.1 |
| 1937 | 41 | 633 | 7.7 | 9.9 | 12.0 | 15.3 |
| Oat, Spring: | | | | | | |
| Graves, 1936 | 1 | 10 | 19.0 | 20.0 | 22.0 | 22.0 |
| Livingston, 1937 | 2 | 40 | 15.0 | 17.0 | 22.0 | 25.0 |
| Barley: | | | | | | |
| Graves, 1936 | 3 | 53 | 3.0 | 5.0 | 8.0 | 12.0 |
| Livingston, 1937 | 2 | 30 | 18.0 | 22.0 | 24.0 | 26.0 |
| Rye: | | | | | | |
| Lyon, 1937 | 2 | 25 | 4.7 | 6.9 | 8.6 | 11.0 |
| McCracken, 1937 | 3 | 15 | 8.0 | 9.5 | 11.0 | 12.0 |
| Trigg, 1937 | 1 | 7 | 0.9 | 4.9 | 6.8 | 10.0 |

gether on the yields of various grain and hay crops, as compared with the application of neither one. These data were obtained on farm-unit test-demonstration farms in the seven Valley counties of western Kentucky.

While unfavorable seasonal conditions made the results variable, they are surprisingly consistent. As shown by Table 15, the use of lime without phosphate appreciably increased the yield of grain crops above those receiving no treatment. The application of phosphate without lime consistently and markedly increased grain yields above those from limed fields. The use of both lime and phosphate consistently and appreciably increased grain yields above those from phosphated fields.

Table 16 shows that, when the yields from fields of legume, grass, and mixed (legume and grass) hays are considered, the results are not so consistent. Without exception, the use of lime alone increased the yields of all hay crops markedly above those

TABLE 16.—*Effect of phosphate and other treatments on yields of hay crops in the seven Valley counties of Kentucky in 1936 and 1937.*

| Crops, Counties, and Years | Total Number of | | Yields From Treatments Named (Lbs.) | | | |
|---|---|---|---|---|---|---|
| | Fields | Acres | None | Lime | Phosphate | Phosphate and Lime |
| Alfalfa: | | | | | | |
| Graves, 1936 | 1 | 5 | 1,000 | 2,000 | 3,000 | 7,000 |
| 1937 | 1 | 5 | 1,040 | 1,440 | 2,520 | 4,440 |
| Livingston, 1936 | 5 | 45 | 1,000 | 1,500 | 2,000 | 2,600 |
| 1937 | 1 | 17.5 | 1,200 | 1,600 | 2,200 | 3,000 |
| Lyon, 1937 | 1 | 20 | 500 | 500 | 600 | 6,000 |
| Marshall, 1936 | 3 | 13 | 3,600 | 4,366 | 4,000 | 5,080 |
| 1937 | 4 | 18 | 3,138 | 3,975 | 4,066 | 5,075 |
| McCracken, 1937 | 6 | 36 | 850 | 1,200 | 2,100 | 3,650 |
| Trigg, 1937 | 8 | 77 | 2,785 | 3,544 | 3,355 | 5,476 |
| Lespedeza: | | | | | | |
| Calloway, 1937 | 6 | 80 | 1,000 | 2,800 | 2,300 | 3,600 |
| Graves, 1936 | 2 | 28 | 2,078 | 3,021 | 3,500 | 3,864 |
| 1937 | 18 | 224.5 | 898 | 1,392 | 1,604 | 2,346 |
| Livingston, 1936 | 7 | 112 | 3,400 | 4,000 | 5,000 | 5,600 |
| 1937 | 7 | 95 | 3,600 | 4,600 | 5,400 | 5,600 |
| Lyon, 1937 | 9 | 116 | 1,036 | 1,871 | 2,177 | 3,846 |
| Marshall, 1936 | 5 | 35 | 1,870 | 2,900 | 2,830 | 3,300 |
| 1937 | 7 | 70 | 1,194 | 1,486 | 1,564 | 2,003 |
| McCracken, 1937 | 33 | 388 | 1,427 | 1,625 | 2,600 | 3,175 |
| Trigg, 1937 | 52 | 789.5 | 1,368 | 2,433 | 2,271 | 4,199 |
| Red Clover: | | | | | | |
| Calloway, 1937 | 2 | 12 | 670 | 3,000 | 1,800 | 4,500 |
| Graves, 1937 | 1 | 5 | 2,400 | 3,128 | 3,000 | 3,200 |
| Lyon, 1937 | 1 | 8 | 3,200 | 3,520 | 4,000 | 3,840 |
| McCracken, 1937 | 4 | 36 | 1,225 | 1,500 | 1,650 | 2,800 |
| Trigg, 1937 | 6 | 79.5 | 952 | 3,373 | 3,262 | 5,803 |
| Red Top: | | | | | | |
| Graves, 1936 | 1 | 5 | 480 | 640 | 1,280 | 1,200 |
| 1937 | 2 | 15 | 800 | 1,467 | 1,573 | 2,667 |
| Timothy: | | | | | | |
| McCracken, 1937 | 4 | 46 | 1,720 | 2,100 | 2,150 | 3,300 |
| Mixed Grass and Legume: | | | | | | |
| Graves, 1936 | 2 | 12 | 894 | 936 | 1,224 | 1,452 |
| 1937 | 5 | 52 | 3,138 | 3,871 | 3,920 | 5,037 |
| Marshall, 1937 | 2 | 15 | 1,600 | 2,080 | 2,345 | 2,950 |

from untreated fields. Without exception, the use of phosphate increased yields of all hay crops above those from untreated fields. In most but not all cases, phosphate increased yields somewhat above those produced by lime alone. There is little consistency in the results. Sometimes the yields from phosphated fields are much larger, sometimes a little larger, and sometimes smaller. When both lime and phosphate are applied, however, the yields usually are increased markedly above those produced by either one alone. Sometimes the increase is enormous. These are short-time results, however, and should not be taken as conclusive.

The State College feels that these test-demonstration results have focussed attention on the fact that most of the farm lands where these materials have been used are in such a state of low productivity that the use of lime and phosphate does not immediately guarantee success in growing grasses and legumes.

*Mississippi Results.* For Mississippi, two sets of data are presented as indicating desirable trends resulting from the use of experimental phosphates in the test-demonstration program. The first data, summarized in Table 17, show the increased yields of winter vetch produced on 88 area test-demonstrations in 1937 by the application of triple superphosphate.

TABLE 17.—*Yields of untreated and phosphated fields of winter vetch and actual and percentage increases from phosphate use, under the conditions named, in 1937.*

| CONDITIONS OF TEST | Number of Farms | Green Weight in Pounds | | | |
|---|---|---|---|---|---|
| | | Treatments | | Gains from Phosphate | |
| | | None | 100 Pounds Phosphate | Pounds | Percent |
| On hill land | 66 | 5,998 | 12,736 | 6,738 | 112 |
| On bench land | 19 | 5,824 | 12,437 | 6,613 | 113 |
| On bottom land | 3 | 6,243 | 10,599 | 4,356 | 69 |
| Total or Average | 88 | 5,968 | 12,600 | 6,632 | 111 |

The other data, presented in Table 18, show the acreages of various soil-protecting and soil-building crops grown in 1935, 1936, and 1937 on specified numbers of farm-unit and area test-demonstrations. The figures indicate that real progress is being made in water and soil conservation and soil building on these farms. It is certain that if all demonstrator reports had been received at the time the tabulations were made, the acreages for 1937 would have been appreciably larger.

TABLE 18.—*Acreages of specified crops sown on indicated numbers of farm-unit and area test-demonstrations in Mississippi in 1935, 1936, and 1937.*

| FARM GROUP AND CROP TREATED | Calendar Years | | | | | |
|---|---|---|---|---|---|---|
| | 1935 | | 1936 | | 1937 | |
| | Number | Acres | Number | Acres | Number | Acres |
| Farm-Unit Test-Demonstrations: | | | | | | |
| Pasture: | | | | | | |
| Old, phosphated | ---------- | 934 | ---------- | 8,367 | 282 | 3,000 |
| New, phosphated | ---------- | 312 | ---------- | 2,663 | | 1,836 |
| Lespedeza: | | | | | | |
| Phosphated | 469 | 198 | 469 | 3,088 | 192 | 2,154 |
| Not phosphated | | 3,827 | | 2,915 | ---------- | ---------- |
| Cowpeas and Soybeans: | | | | | | |
| Phosphated | 469 | 176 | ---------- | 3,443 | 274 | 3,754 |
| Not phosphated | | 3,580 | | 2,562 | ---------- | ---------- |
| Winter Legumes: | | | | | | |
| Phosphated | 469 | 1,178 | 469 | 3,326 | 323 | 9,317 |
| Not phosphated | | 1,526 | | 1,903 | ---------- | ---------- |
| Black Locust | ---------- | 84 | ---------- | 337 | 23 | 90 |
| Kudzu | ---------- | 1 | ---------- | 27 | 14 | 168 |
| Area Test-Demonstrations: | | | | | | |
| Pasture: | | | | | | |
| Old, phosphated | ---------- | ---------- | 682 | 3,327 | 222 | 759 |
| New, phosphated | ---------- | ---------- | | 471 | | 617 |
| Lespedeza | ---------- | ---------- | 682 | 3,444 | 86 | 312 |
| Cowpeas and Soybeans | | | | | 457 | 4,017 |
| Winter Legumes | 682 | 458 | 682 | 3,723 | 378 | 4,316 |
| Black Locust | ---------- | ---------- | ---------- | ---------- | 31 | 55 |

*North Carolina Results.* For North Carolina, three groups of data indicative of progress are set forth.

Table 19 shows the changes which 603 farm-unit test-demonstration farmers in 17 counties have made in land use in readjusting their farm management programs with the aid of the phosphate test-demonstrations. The decreases in acreage of land cultivated and in row crops are encouraging. The large and significant increases in the acreages of the protecting and building

TABLE 19.—*Changes of acreage and specified classes of crops or land on 603 farm-unit test-demonstration farms in 17 counties of North Carolina in the years 1935, 1936, and 1937, with percentage change in the period.*

| CROP LAND CLASS, OR TREATMENT | Total Acreage | | | Change Per cent |
|---|---|---|---|---|
| | 1935 | 1936 | 1937 | |
| All land in cultivation | 28,139 | 23,158 | 24,078 | −14 |
| Row Crops | 9,530 | 8,441 | 8,126 | −15 |
| Small Grains | 5,833 | 6,307 | 6,020 | 3 |
| Improved pasture | 6,538 | 8,919 | 10,993 | 68 |
| Meadow | 3,216 | 3,398 | 3,674 | 14 |
| Lespedeza | 5,155 | 6,996 | 7,344 | 42 |
| Other legumes | 2,281 | 3,118 | 4,094 | 79 |
| All improving crops | 12,284 | 15,774 | 18,521 | 59 |
| Land subject to severe erosion | 5,130 | 4,931 | 5,152 | 0.4 |
| Eroding land planted to trees | 240 | 492 | 705 | 193 |
| Steep land (10% slope or more) in sod crops | 8,143 | 9,389 | 10,856 | 33 |
| Land limed | 2,229 | 4,644 | 5,944 | 158 |

crops indicate that the test-demonstration farmers are making progress.

In Watauga County, a farm-management analysis of test-demonstration farms has been started. Some results of the study of crop and livestock changes between 1935 and 1937, on 89 farm-unit test-demonstration farms and 48 farms of non-demonstrators, are presented in Tables 20 and 21. The increases in improved pasture and total meadow land and marked decrease in corn are encouraging. So too are the increases in colts, total cattle, and breeding hogs. In all cases, these changes are much greater on the farms of test-demonstrators than on those of non-demonstrators.

TABLE 20.—*Data showing acreages and percentages of total farm land devoted to specified uses on 89 test-demonstration farms and 48 non-demonstration farms in Watauga County, North Carolina, in 1935 and 1937, and the percentage of shifts of acreage within the period.*

| FARM GROUP AND CROP ITEMS | Acres Per Farm | | Percentage of Total Land | | Change |
|---|---|---|---|---|---|
| | 1935 | 1937 | 1935 | 1937 | |
| Farm-Unit Test Demonstrators: | | | | | |
| All crops (including meadow) | 31.0 | 27.8 | 24.1 | 21.7 | −10.1 |
| Idle Land | 1.4 | 1.0 | 1.1 | 0.8 | −30.2 |
| Pasture sown since 1930 | 17.7 | 23.9 | 13.8 | 18.6 | 35.4 |
| Other pasture | 31.9 | 28.8 | 24.9 | 22.5 | −9.8 |
| Woodland | 43.6 | 44.1 | 34.0 | 34.4 | 1.1 |
| Farmstead, roads, etc. | 2.6 | 2.6 | 2.1 | 2.0 | −1.4 |
| Totals, all land | 128.2 | 128.2 | 100.0 | 100.0 | ---------- |
| All Crops Subdivided: | | | | | |
| Tobacco | .2 | .4 | .7 | 1.5 | 91.2 |
| Corn | 7.9 | 5.0 | 25.6 | 18.0 | −47.0 |
| Grains | 7.4 | 6.2 | 23.8 | 22.1 | −16.7 |
| Truck Crops | 5.3 | 3.3 | 17.0 | 12.1 | −36.3 |
| Orchard Crops | .4 | .6 | 1.3 | 2.1 | 52.1 |
| Hay and Meadow | 9.8 | 12.3 | 31.6 | 44.2 | 25.9 |
| Totals | 31.0 | 27.8 | 100.0 | 100.0 | −10.1 |
| Non-Demonstrators: | | | | | |
| All crops (including meadow) | 28.5 | 28.2 | 20.3 | 20.0 | −1.1 |
| Idle Land | 0.5 | 0.8 | 0.3 | 0.6 | 55.1 |
| Pasture sown since 1930 | 16.3 | 17.8 | 11.6 | 12.7 | 9.5 |
| Other pasture | 43.3 | 42.7 | 30.9 | 30.4 | −1.4 |
| Woodland | 49.0 | 48.2 | 34.9 | 34.3 | −1.5 |
| Farmstead, roads, etc. | 2.8 | 2.8 | 2.0 | 2.0 | 0. |
| Totals, all land | 140.4 | 140.5 | 100.0 | 100.0 | ---------- |
| All Crops Subdivided: | | | | | |
| Tobacco | 0.5 | 0.5 | 1.5 | 1.7 | 10.5 |
| Corn | 7.7 | 6.5 | 26.9 | 23.2 | −14.6 |
| Grains | 5.9 | 5.8 | 20.9 | 20.7 | −9.8 |
| Truck Crops | 4.1 | 3.7 | 14.4 | 13.2 | −9.4 |
| Orchard Crops | 0.8 | 0.9 | 2.9 | 3.1 | 6.9 |
| Hay and Meadow | 9.5 | 10.7 | 33.4 | 38.1 | 11.3 |
| Totals | 28.5 | 28.1 | 100.0 | 100.0 | −1.1 |

TABLE 21.—*Data showing numbers of different groups and kinds of animals on 89 farm-unit test-demonstration farms and 48 non-demonstration farms in Watauga County, North Carolina, in 1935 and 1937, and the percentage shifts in numbers in the period.*

| FARM GROUPS AND CLASSES AND KINDS OF ANIMALS | Total Numbers on Farms Specified | | Average Number Per Farm | | Percentage Change |
|---|---|---|---|---|---|
| | 1935 | 1937 | 1935 | 1937 | |
| Farm-Unit Test-Demonstrations: | | | | | |
| Work Animals: | | | | | |
| Horses | 140 | 140 | 1.6 | 1.6 | ---------- |
| Colts | 27 | 44 | 0.3 | 0.5 | 60.0 |
| Mules | 9 | 5 | 0.1 | 0.1 | −44.4 |
| Oxen | 4 | 5 | 0.1 | 0.1 | 25.0 |
| Beef and Milk Cattle: | | | | | |
| Bulls | 28 | 23 | 0.3 | 0.3 | −17.9 |
| Cows | 342 | 393 | 3.8 | 4.3 | 14.9 |
| Young Stock | 545 | 622 | 6.1 | 7.0 | 14.1 |
| Calves | 68 | 111 | 0.7 | 1.2 | 63.2 |
| Totals | 983 | 1,149 | 11.0 | 12.9 | 11.7 |
| Smaller Animals: | | | | | |
| Sheep | 1,081 | 900 | 12.1 | 10.0 | −16.8 |
| Lambs | 426 | 397 | 4.8 | 4.5 | −6.9 |
| Boars and Brood Sows | 28 | 60 | 0.3 | 0.7 | 114.6 |
| Other Hogs | 416 | 414 | 4.7 | 4.7 | 0.0 |
| Poultry | 5,322 | 4,964 | 59.8 | 55.8 | −6.7 |
| Non-Demonstrators: | | | | | |
| Work Animals: | | | | | |
| Horses | 86 | 88 | 1.8 | 1.8 | 2.2 |
| Colts | 6 | 24 | 0.1 | 0.5 | 300.0 |
| Mules | 13 | 19 | 0.3 | 0.4 | 46.2 |
| Oxen | 2 | 2 | 0.0 | 0.0 | 0.0 |
| Beef and Milk Animals: | | | | | |
| Bulls | 10 | 9 | 0.2 | 0.2 | −10.0 |
| Cows | 177 | 176 | 3.7 | 3.7 | −0.5 |
| Young Stock | 364 | 396 | 7.5 | 8.2 | 8.8 |
| Calves | 54 | 58 | 1.1 | 1.2 | 7.4 |
| Totals | 605 | 639 | 12.6 | 13.3 | 5.6 |
| Smaller Animals: | | | | | |
| Sheep (and goats) | 584* | 595* | 12.1 | 12.4 | 1.9 |
| Lambs | 334 | 308 | 7.0 | 6.4 | −7.8 |
| Boars and Brood Sows | 26 | 23 | 0.5 | 0.5 | −11.5 |
| Other Hogs | 168 | 168 | 3.5 | 3.5 | 0.0 |
| Poultry | 2,089 | 2,054 | 43.5 | 42.8 | −1.7 |

*Includes 2 goats in 1935 and 20 in 1937.

*Tennessee Results.* The State of Tennessee contains approximately one-half of the counties and of the land area in the entire Tennessee River watershed. Her share of the test-demonstration program, both farm-unit and area, is correspondingly large.

A special study has been made of the land use which 338 farm-unit demonstrators planned to make and actually made in the years 1935, 1936, and 1937. These data are given in Table 22.

Tennessee also has made a study of 840 representative test-demonstration farms for the years 1935 to 1937. Their shifts in acreages of erosion-permitting crops to those conserving soil and water have been tabulated. An attempt has been made to estimate the losses of soil and of water from their lands occupied by different classes of crops. These estimates are presented in Table 23.

TABLE 22.—*Planned and actual percentage land use for specified purposes on 338 farm-unit test-demonstration farms in Tennessee in the three years 1935, 1936, and 1937, with totals and percentage shifts by use groups.*

| CROPS AND OTHER USES | Land Use on a Percentage Basis | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Planned | | | | Actual Records | | | |
| | 1935 | 1936 | 1937 | Change | 1935 | 1936 | 1937 | Change |
| Corn | 11.68 | 11.20 | 10.44 | −1.24 | 12.00 | 10.81 | 10.57 | −1.43 |
| Cotton | 1.99 | 1.78 | 1.80 | −0.19 | 1.87 | 1.59 | 1.76 | −0.11 |
| Tobacco | 0.15 | 0.15 | 0.08 | −0.07 | 0.28 | 0.24 | 0.37 | −0.19 |
| Truck and Garden Crops | 0.63 | 0.64 | 0.63 | 0.00 | 0.58 | 0.70 | 0.73 | 0.15 |
| Fruit Trees | 0.00 | 0.56 | 0.56 | +0.00 | 1.10 | 1.03 | 0.96 | −0.14 |
| Other Row Crops* | 0.22 | 0.17 | 0.16 | −0.06 | 0.46 | 0.46 | 0.30 | −0.16 |
| Total Row Crops | 15.23 | 14.55 | 13.67 | −1.56 | 16.29 | 14.83 | 14.69 | −1.60 |
| Alfalfa Hay | 0.50 | 0.74 | 0.83 | 0.33 | 0.41 | 0.45 | 0.73 | 0.32 |
| Red Clover Hay | 2.75 | 3.41 | 4.17 | 1.42 | 1.60 | 1.97 | 1.65 | 0.05 |
| Lespedeza Hay and Seed | 14.43 | 13.99 | 14.18 | −0.25 | 9.83 | 10.30 | 9.54 | −0.29 |
| Grass Hay | 2.48 | 2.73 | 3.27 | 0.79 | 3.68 | 2.53 | 4.39 | 0.71 |
| Grain and Winter Legume | 5.87 | 9.33 | 8.06 | 2.19 | 6.59 | 7.26 | 7.66 | 1.07 |
| Summer Legumes, Millets | 1.39 | 1.06 | 0.70 | −0.69 | 1.50 | 1.79 | 2.06 | 0.56 |
| Total Hay and Legumes | 27.42 | 31.29 | 31.21 | 3.79 | 23.61 | 24.30 | 26.03 | 2.42 |
| Less Double Cropped | | | | | 4.37 | 4.15 | 4.69 | 0.32 |
| Actual Totals | | | | | 19.24 | 20.15 | 21.34 | 2.10 |
| Open Pasture | 23.43 | 23.81 | 23.61 | 0.18 | 26.13 | 28.25 | 28.01 | 1.88 |
| Total Protecting Crops | | | | | 45.37 | 48.40 | 49.35 | 3.98 |
| Idle Land | | | | | 3.39 | 1.54 | 1.73 | −2.16 |
| Woodland | | | | | 23.75 | 28.84 | 28.36 | −0.39 |
| Waste land (farmsteads, roads, etc.) | | | | | 6.20 | 6.39 | 6.37 | 0.17 |
| Totals | | | | | 38.34 | 36.77 | 35.96 | −2.38 |

*Includes potato and sweet potato.

TABLE 23.—*Percentage land use on 840 test-demonstration farms in Tennessee in 1935 and 1937, with estimated water runoff and soil loss per acre from each land use.*

| CROP OR OTHER LAND USE | 1935 | | | 1937 | | |
|---|---|---|---|---|---|---|
| | Acres Percent | Loss of | | Acres Percent | Loss of | |
| | | Water, Acre Inches | Soil Tons | | Water, Acre Inches | Soil Tons |
| Row crops | 15.6 | 4.06 | 16.22 | 14.7 | 3.82 | 15.29 |
| Grain, grass hay, lespedeza, and others | 17.7 | 2.30 | 2.30 | 19.2 | 1.92 | 0.97 |
| Alfalfa, red clover, and pasture | 27.4 | 2.74 | 0.55 | 30.5 | 1.83 | 0.31 |
| Idle crop land | 4.0 | 1.04 | 4.16 | 1.7 | 0.44 | 1.77 |
| Woodland and waste land | 35.3 | 2.47 | 0.71 | 33.9 | 2.37 | 0.68 |
| Totals | 100 | 12.61 | 23.94 | 100 | 10.38 | 19.02 |

Tennessee furnishes an interesting example of an area or community demonstration. Wheat Community is a watershed demonstration and an example of community planning. It is located in Roane County and comprises 133 farms containing 11,119 acres. The community is one of the oldest in Tennessee. At the time this community was organized, the farms were badly run down,

eroded, and gullied, and crop yields were very low. Most of the tillable lands were in cultivated (row) crops and the livestock population was low. This resulted in an average income of about $200 per farm.

The farms varied in size but about one-third had less than 50 acres, one-third had 50 to 100 acres, and the remainder had more than 100 acres. Actual holdings range from about one-half acre to one farm of 515 acres.

There were 194 families living on the 133 farms, with a total of 734 persons, all white. The population consisted of 283 people under 15 years, 230 between 15 and 35, 157 between 36 and 60, and 64 over 60 years. Only 20 persons, or about 3 per cent, had employment outside of the area.

The progress made in the Wheat Community is very well shown by comparing the 1937 goals with the 1937 accomplishments:

| | Goals | Accomplishments |
|---|---|---|
| Acres terraced | 200 | 20 |
| Acres limed | 1,300 | 1,275 |
| Tons of lime used | 1,300 | 2,000 |
| Acres of cover crops | 2,000 | 1,300 |
| Acres phosphated | 1,000 | 1,125 |
| Mail boxes painted | 50 | 53 |
| Homes painted | 10 | 9 |
| New fencing | 17,000 ft. | 24,700 ft. (1,500 rods) |

*Virginia Results.* The eleven Valley Counties of Virginia, and many of those outside the Tennessee River watershed, are mountainous and farming is largely of the livestock type. The necessity for controlling soil and water movement on the steep slopes and of providing adequate pasture and hay for livestock makes these farmers particularly interested in the test-demonstration program. Relatively large numbers of participating farmers have been obtained and relatively rapid progress made. Some of the items of achievement are set forth below. In Table 24 are shown

TABLE 24.—*Numbers and acreages of farm-unit, area, and preliminary area test-demonstration farms in the Valley and non-Valley Counties of Virginia, together with acres phosphated and experimental phosphates received, to May 10, 1938.*

| ITEMS OF PROGRESS FOR TEST-DEMONSTRATION FARMS | In Valley Counties | In Non-Valley Counties | In All Counties |
|---|---|---|---|
| Numbers of Farm-Unit Farms | 344 | 515 | 859 |
| Acres in Farm-Unit Farms | 84,000 | 118,027 | 202,027 |
| Acres treated in Farm-Unit Farms | 44,600 | 29,245 | 73,845 |
| Numbers of Area Farms | 2,300 | 0 | 2,300 |
| Acres in Area Farms | 318,359 | 0 | 318,359 |
| Acres treated in Area Farms | 69,394 | 0 | 69,394 |
| Numbers of Preliminary Area Farms | 1,106 | 0 | 1,106 |
| Acres in Preliminary Area Farms | 191,308 | 0 | 191,308 |
| Acres treated in Preliminary Area Farms | 19,816 | 0 | 19,816 |
| Numbers of all Demonstration Farms | 3,750 | 515 | 4,265 |
| Acres in all Demonstration Farms | ---------- | ---------- | 711,694 |
| Acres treated in all Demonstration Farms | ---------- | ---------- | 163,055 |
| Tons experimental phosphates received | 11,466 | 2,668 | 14,134 |
| Tons of lime applied on all farms | ---------- | ---------- | 58,000 |

the numbers and acreages of test-demonstration farms of all kinds and the acreages which have been treated with experimental phosphates and often with lime also.

The reports of test-demonstration farmers contain abundant data indicating progress made in the establishment of crops promoting the control of soil and water movement, and maintaining or increasing soil fertility. Recognizing the aid given by the use of TVA experimental phosphates in achieving these results, these farmers already have begun to purchase additional commercial phosphates in order to extend their program. Their reports show also the vigorous efforts they are making to protect their soils from washing away through the influence of runoff water.

In addition to the use of pasture, meadow, and other protecting crops, many demonstrators have made use of other practices. Some utilize strip cropping. Many have transferred their row crops from the steep and eroding slopes to the more level lands on their farms. Most of them have protected their lands in winter by use of winter cover crops. Many others have reclaimed badly eroded land by terracing, gully damming, reforestation, and other methods. Statistical data illustrating this progress are given in Table 25.

TABLE 25.—*Data showing progress made in controlling soil and water movement on demonstration farms in Virginia by use of experimental phosphates on pasture, meadow, and other grass and legume crops, by other land-use and farm-management adjustments, and by mechanical methods.*

| ITEMS OF TEST-DEMONSTRATION FARM PROGRESS | Acres, Demonstrators Tons, Etc. |
|---|---|
| Old pasture phosphated, limed, reseeded, etc., acres | 122,300 |
| New pasture established and/or treated, acres | 20,070 |
| Other legumes, meadows, etc., seeded and/or treated, acres | 20,685 |
| Total acres of above items | 163,055 |
| Alfalfa established on demonstration farms, acres | 3,300 |
| Lespedeza sown on demonstration farms, acres | 80,700 |
| Pastures treated with purchased phosphates, acres | 12,680 |
| Demonstrators saving legume and/or grass seed | 484 |
| Demonstrators practicing strip cropping | 470 |
| No-plow or modified no-plow farms | 40 |
| Row crops transferred from steep, eroding lands, acres | 12,530 |
| Conserving and restoring crops replacing other crops, acres (approx.) | 30,000 |
| Demonstrators protecting all cultivated land by winter cover crops | 3,487 |
| Eroded land reclaimed or improved through mechanical methods, acres | 8,700 |
| Terraces constructed on demonstration farms, acres | 1,060 |
| Marginal or submarginal lands forested, acres | 690 |
| Estimated soil saved by above practices, tons | 3,500,000 |
| Estimated water conserved by above practices, per cent | 20 |

### B. TERRACING EQUIPMENT AND PROGRESS

The building of mechanical structures, such as terraces, is recognized as an indispensible aid in soil conservation and land-use adjustment. It strongly supplements the farm test-demonstrations through holding both soil and water while grass and legume crops are becoming established and through protecting the fields sown to row crops. For these reasons, the Valley States Land-Grant Colleges, through their Extension Divisions, have

promoted terracing vigorously. The Authority has cooperated with them in promoting and supervising the work in those counties lying wholly or chiefly in the Valley area. These activities have been described under Cooperative Programs Developed.

This cooperative program was started in Alabama, in 1935, with 10 large power outfits. Data showing the numbers of Valley-area counties in each of the six States, and the ownership and numbers of the different kinds of terracing outfits operating in those counties of each State during the fiscal year ending June 30, 1938, are presented in Table 26. This program is not conducted in the Valley counties of Virginia. The figures show that 70 large power outfits and more than 5,000 smaller farm outfits were in operation during the fiscal year.

TABLE 26.—*The numbers of Valley counties in each of six States, and the numbers and ownership of the different kinds of terracing outfits operating in those counties of each State during the fiscal year ending June 30, 1938.*

| STATE | Number of Valley Counties | Large Power Outfits | | Small Power and Horse-Drawn Outfits |
|---|---|---|---|---|
| | | Commercially Owned | Association Owned | Farmer Owned |
| Alabama | 15 | 5 | 28 | 3,002 |
| Georgia | 9 | 0 | 5 | 240 |
| Kentucky | 7 | 1 | 3 | 36 |
| Mississippi | 3 | 0 | 4 | 81 |
| North Carolina | 15 | 0 | 2 | 39 |
| Tennessee | 59 | 8 | 14 | 1,657 |
| Totals | 108 | 14 | 56 | 5,055 |

The numbers of acres terraced by both major kinds of terracing outfits, in each of the four fiscal years from 1935 to 1938, in the 108 counties of the six States, with the 4-year totals, are shown in Table 27. The figures show a total of more than 360,000 acres terraced, or the equivalent of 565 square miles. To carry surplus drainage waters safely from the terrace systems requires the cutting of adequate drainage ditches. These usually average about one mile in length for each square mile terraced.

### C. RELOCATION OF DISPLACED RESERVOIR FAMILIES

The nature of the problem has been presented earlier, under the discussion of Cooperative Programs Developed. The Land-Grant Colleges in the three States affected, through their Extension Divisions, have shared the labor and expense involved, in cooperation with the Authority.

The assistance rendered to these displaced families has been both immediate and continued. Immediate help has included the actual problem of relocating. Lists of farms for sale or rent have been compiled. Appraisals have been provided for prospective purchasers. Mistakes to be avoided in land purchases have been pointed out. Continued advisory assistance has covered the planning of enterprises on the new farm and in the farm home, ad-

TABLE 27.—*Numbers of acres terraced in 108 Valley counties of six States, by large power and small farm outfits, in each of the four fiscal years, 1935 to 1938, inclusive, with annual and 4-year totals.*

| STATES | 1935 | | | 1936 | | | 1937 | | | 1938 | | | 4-year Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Power | Farm | Total | Power | Farm | Total | Power | Farm | Total | Power | Farm | Total | |
| Alabama | 21,632 | 18,548 | 40,180 | 41,998 | 16,809 | 58,807 | 45,000 | 26,926 | 70,926 | 40,687 | 29,388 | 70,075 | 239,988 |
| Georgia | 526 | 425 | 951 | 863 | 2,841 | 3,704 | 2,416 | 2,788 | 5,204 | 2,550 | 1,754 | 4,304 | 14,163 |
| Kentucky | 239 | 70 | 309 | 2,932 | 86 | 3,018 | 2,859 | 140 | 2,999 | 1,910 | 149 | 2,059 | 8,385 |
| Mississippi | 1,907 | 223 | 2,130 | 2,951 | 634 | 3,585 | 1,148 | 1,007 | 2,155 | 1,597 | 882 | 2,479 | 10,349 |
| North Carolina | | | | 681 | 418 | 1,099 | 373 | 540 | 913 | 263 | 531 | 794 | 2,806 |
| Tennessee | 9,334 | 293 | 9,627 | 22,600 | 2,182 | 24,782 | 12,513 | 13,386 | 24,899 | 11,143 | 14,657 | 25,800 | 86,108 |
| Totals | 33,638 | 19,559 | 53,197 | 72,025 | 22,970 | 94,995 | 64,309 | 43,787 | 103,096 | 58,150 | 47,361 | 105,511 | 361,799 |

vice on obtaining needed equipment, and help in becoming acquainted in the new community and tied into the community organizations.

The approximate acreages comprised in the reservoir areas of three completed dams and of three now under construction are presented below, in Table 28, together with the total of resident families and the number relocated. The acreages given are those actually within the timber clearance line, which usually is at or slightly above the maximum water level. For convenience, the acreages of open land (non-woodland) in the several reservoir areas are given also. This open land includes homesites, highways, and railways, but not the stream channels.

TABLE 28.—*Approximate acreages in six TVA reservoir areas, including acres in reservoir site and protective border, the total acreage, and the open land, together with the numbers of families displaced and those already relocated, to June 30, 1938.*

| Reservoir Areas | Acres in Reservoir Areas | | | | Number of Families | |
|---|---|---|---|---|---|---|
| | Protective Border | Reservoir Site | | Grand Total | Total | Relocated |
| | | Total | Open Land | | | |
| Construction Completed: | | | | | | |
| Norris, Tennessee | 90,150 | 34,200 | 21,400 | 124,350 | 3,501 | 3,501 |
| Wheeler, Alabama | 36,400 | 67,100 | 18,400 | 103,500 | 840 | 840 |
| Pickwick Landing, Miss. | 20,500 | 43,000 | 21,100 | 63,500 | 815 | 815 |
| Under Construction: | | | | | | |
| Guntersville, Alabama | 43,400 | 66,600 | 33,600 | 110,000 | 1,943 | 390 |
| Chickamauga, Tennessee | 24,500 | 33,500 | 21,100 | 58,000 | 1,500 | 207 |
| Hiwassee, North Carolina | 17,200 | 6,300 | 2,400 | 23,500 | 250 | 126 |
| Totals | 232,150 | 250,700 | 118,000 | 482,850 | 8,849 | 5,879 |

Wilson Dam, at Muscle Shoals, Alabama, was constructed, and its reservoir site was purchased, by the Army Engineer Corps several years before the Tennessee Valley Authority was created.

Special studies of the relocation problems in the Norris Reservoir area have been made by the Tennessee Extension Division. This area included parts of five counties and involved 3,553 families. Of these, 2,260 families were owners and 1,293 families (all white) were tenants. Questionnaire schedules were filled by 1,920 owner families and 1,033 tenant families, a total of 2,953 schedules.

The reservoir area was divided in 26 communities, for relocation purposes, and community committees organized in each, with a total of 78 leaders of activities. These 26 community committees held 104 meetings, attended by 5,800 persons. Monthly joint meetings of all community committees were held.

In addition, 90 community committees were organized, with 450 leaders, in 18 other counties in which sufficient numbers of displaced families desired to relocate. These 90 committees held 313 meetings, attended by 6,851 persons. In the process of relocation, 3.5 contacts were made per family, on the average, among

the 2,260 owner families and 3.18 contacts per family among the 1,293 tenant families. Lists of 3,857 farms for sale or lease were compiled for use of displaced families and 1,282 of these farms were appraised by relocation appraisers. Among owner families, 643 families (28.5 per cent) and/or 4,879 individuals were taken to inspect farms for prospective purchase. On an average, 3.42 trips per family were made. Among tenant families, 218 families (16.9 per cent) and/or 1,023 individuals were taken to inspect farms, with an average of 3.13 trips per family.

Through relocation, 61 owners, or 2.7 per cent, became tenants. On the other hand, 118 tenants, or 9.12 per cent, became owners. Of the 1,293 tenants, 388 or 30 per cent relocated with their former landlords.

In a study of the final geographical location of the relocated families it was found that 2,426 or 68 per cent of the 3,553 families remained in one of the five counties containing the reservoir area. Of the other 1,127 families, 945 or 26.6 per cent settled in 30 other counties in Tennessee and only 182 families or 5.4 per cent removed from the State.

The Tennessee Extension Division made a questionnaire survey recently to determine the present status of relocated families from the Norris Reservoir area. Of the 3,593 original families, 1,813 or 51 per cent replied. These comprised 1,250, or 55.3 per cent, of the former owner families and 563, or 43.5 per cent, of the former tenant families. The status of these relocated families is presented by four attitude groups in Table 29.

TABLE 29.—*Recent attitude status of 1,813 relocated families from the Norris Reservoir area.*

| Attitude Status Reported | Owners | | Tenants | | Total | |
|---|---|---|---|---|---|---|
| | Number | Percent | Number | Percent | Number | Percent |
| "Satisfied" or "Pleased" | 590 | 47.2 | 268 | 47.6 | 858 | 47.3 |
| "No Particular Difference" | 307 | 24.6 | 111 | 19.7 | 418 | 23.1 |
| "Dissatisfied" or "Displeased" | 277 | 22.1 | 121 | 21.5 | 398 | 21.9 |
| Reports Indefinite | 76 | 6.1 | 63 | 11.2 | 139 | 7.7 |
| Totals | 1,250 | 100.0 | 563 | 100.0 | 1,813 | 100.0 |

### D. AGRICULTURAL TRAINING OF RESERVOIR-CLEARANCE EMPLOYEES

For the most part, these employees who clear the timber from the reservoir areas are farmers living in or near the area being cleared. Because it is desirable to spread the work as widely as possible, they usually are employed on a part-time basis. This gives them opportunity to work part time on their farms. It also provides opportunity to give them useful training in agriculture while they are so employed. So far as possible, the training given is designed to make them better farmers, specially equipped for some particular line of farm production or related craft which will help to insure a better income and living.

The number of reservoir-clearance employees fluctuates with the seasons and more especially with the progress of work on the

different clearance areas. Figures for any one month or any one year, therefore, are not directly comparable with those for another month or another year. The nature of the training activities undertaken also varies with the season and with the type of farming suited to the area. With these facts in mind, some summarized data may be presented.

(1) *Employee Participation in Training Activities.* The training of reservoir-clearance employees in various agricultural activities was undertaken first in 1934-35 for those employed on the Wheeler Reservoir area. No such program was undertaken for those clearing the Norris Reservoir area.

The study club activities attracted 1,318 employees in 1935 and more than 2,000 in 1936. More than 760 were taking part in June, 1936, and this number constituted approximately 92 percent of all those then working who had been employed prior to May 1 of that year and therefore had had time to get started in the training work. Some also were serving as chairmen of their community groups, while still others were members of important committees. A summary of the activities conducted in the Wheeler area in fiscal year 1935 and in the Wheeler and Pickwick areas in fiscal year 1936, is presented in Table 30.

TABLE 30.—*A summary of agricultural training activities for reservoir-clearance employees in the Wheeler Reservoir area in the fiscal year 1935, and in the Wheeler and Pickwick Reservoir areas in the fiscal year 1936.*

| ACTIVITIES | | | INDIVIDUALS INVOLVED | | |
|---|---|---|---|---|---|
| Kinds | Numbers | | Kinds | Numbers | |
| | 1935 | 1936 | | 1935 | 1936 |
| Study clubs organized: Adult | 41 | 108 | Persons | 1,318 | 3,851 |
| Study clubs organized: Junior | 7 | 51 | Persons | 141 | 1,440 |
| Study club meetings held | | 1,283 | Attendance | | 32,891 |
| Total meetings held | 250 | | Attendance | 8,328 | |
| Demonstration meetings held | | 2,467 | Attendance | | 30,645 |
| Garden demonstrations conducted | 715 | 802 | Acres | 318 | |
| Orchard demonstrations conducted | | 262 | | | |
| Feed-production demonstrations conducted | 75 | 844 | Acres | 176 | |
| Seed-production demonstrations conducted | 157 | 658 | Acres | 238 | |
| Pasture demonstrations conducted | | 257 | | | |
| Winter-legume demonstrations conducted | | 270 | | | |
| Cotton demonstrations conducted | | 674 | | | |
| Livestock demonstrations conducted | 78 | 867 | Animals | 149 | |
| Poultry demonstrations conducted | 40 | | Chickens | 1,376 | |
| Terracing demonstrations conducted | | 96 | | | |
| Miscellaneous demonstrations conducted | | 236 | | | |
| Different demonstrators involved | | | | 958 | |

At the end of the fiscal year 1937, there were 1,652 employees participating in the training program and 7,837 farm demonstrations were under way. At the end of the fiscal year 1938, there were 648 employees taking part and 3,433 farming demonstrations were being conducted. These employees were engaged in reservoir-clearance operations in three States: Alabama, Mississippi, and Tennessee. Summaries of the major activities for these two fiscal years are presented in Table 31.

TABLE 31.—*Summaries of major training activities of reservoir-clearance employees, and of the supervising personnel, in the fiscal years 1937 and 1938.*

| ACTIVITIES | Numbers | | Attendance | |
|---|---|---|---|---|
| | 1937 | 1938 | 1937 | 1938 |
| Training Meetings Held by Employees: | | | | |
| Demonstrations of Methods | 2,737 | 1,767 | 14,408 | 10,188 |
| Demonstrations of Results | 2,657 | 1,393 | 12,941 | 9,758 |
| Study Clubs | 1,290 | 745 | 58,167 | 33,946 |
| General Purposes | 1,614 | 1,378 | 77,354 | 75,537 |
| Total Attendance | | | 162,870 | 129,429 |
| Visits by Supervising Personnel to: | | | | |
| Demonstrations | 8,056 | 7,579 | | |
| Farms of clearance employees | 6,277 | 3,822 | | |
| All farms | 17,889 | 14,799 | | |

Some of the demonstrations being conducted, such as those in seed production, winter legumes, etc., are related to the cooperative use of Authority lands in the reservoir areas, discussed a little farther on.

(2) *Employee Investment of Moneys Earned.* It was noted earlier, in the description of cooperative activities, that one of the objects of the training program for reservoir-clearance employees was to teach methods of farm planning and budgeting and to aid them in the wise use of the moneys received by them for their work in clearing reservoir sites.

During the fiscal years 1936 and 1937, attempts were made to discover what use these employees were making of the extra money they earned by clearance operations. Some facts were obtained in 1936 which showed that the employees had invested the moneys in the following ways:

58 purchased land
159 improved homes and buildings
405 purchased equipment
159 purchased work stock
198 purchased cows
480 purchased hogs
997 improved crop production
719 paid back debts

In the winter of 1936-37, the Mississippi Extension Service made a questionnaire survey of the use of funds by the reservoir-clearance employees on the Pickwick Reservoir area in Mississippi. They had been employed on a half-time basis. The 274 questionnaires returned show that that number of employees invested $81,000 in improvements, of which sum $36,163 were derived from their work for the TVA and $44,837 were derived from crops and other income sources. The ways in which $71,870 of these moneys were applied are shown in Table 32.

TABLE 32.—*Numbers of reservoir-clearance employees, in the Pickwick Reservoir area in Mississippi, who invested their funds for specified purposes, and the amounts so expended, in the fiscal year 1937.*

| PURPOSE OF EXPENDITURE | Number of Employees | Amount Expended |
|---|---|---|
| Back debts | 197 | $ 20,374 |
| Land | 33 | 4,179 |
| Farm machinery | 107 | 2,622 |
| Building improvement | 55 | 2,099 |
| Fertilizers | 212 | 4,845 |
| Feeds (corn, hay, etc.) | 91 | 2,436 |
| Feeds (other) | 105 | 2,012 |
| Labor | 185 | 5,078 |
| Work stock (partial payments) | 81 | 1,108 |
| Hogs | 129 | 1,058 |
| Home improvement | 58 | 5,854 |
| Furniture | 147 | 5,906 |
| Automobiles | 58 | 13,030 |
| Radios | 37 | 1,269 |
| Total | | $ 71,870 |

### E. IMPROVEMENT OF AUTHORITY-OWNED RESERVOIR LANDS

In purchasing reservoir sites, the Authority purchases a protective border above high-water mark in order to be able to control destructive erosion and consequent silting of the reservoir, as explained in the description of cooperative programs developed. It was realized promptly that any considerable areas of unused former crop land would be subject to severe erosion and consequently would be a menace to the reservoirs. In February, 1936, a conference was held by representatives of the Alabama Extension Service, the Tennessee Valley Authority, and members of the county soil conservation associations in the Wheeler Reservoir area. At this conference, the farmers of the Area Soil Conservation Association proposed a plan for seeding lespedeza on as much of the old crop land as possible.

The plan involved the classification of the land as poor, fair, and good, the handling of each class in a different way, and with a different rate of payment for each method. The Authority was to furnish the lespedeza seed, with needed phosphates and lime. The farmers were to do the work and to receive payment in cash or crop, depending on the land classification and the methods used. This was an excellent illustration of public spirit on the part of the farmer organization and an instance of effective and satisfactory collective bargaining.

The poor land, totaling 6,755 acres, was sown to lespedeza without preparation, the farmers receiving 20 cents per acre for their work. The fair land, to the extent of 7,463 acres, was disked and harrowed and sown to lespedeza, the farmers receiving 60 cents per acre. The best land, totaling 2,458 acres, was sown to oats and lespedeza, the farmers furnishing the oat seed and taking the oat crop as their compensation. Some choice seed of Korean and Tennessee 76 lespedeza was obtained and sown on 602 acres for the raising of pure seed. For this special seeding farmers received $1.50 per acre. In this way some 17,278 acres were pro-

tected in the Wheeler Reservoir area in 1936. The State College and the Authority jointly supervised the seeding and the harvest.

Agreements were made later by the Authority with farmers in the Wheeler area to harvest some of the lespedeza seed on shares. In this way, the Authority obtained approximately 66,000 pounds of seed in the autumn of 1936. This was used in seeding additional reservoir acreage in 1937.

Farmers were well pleased with their experience in 1936 and asked to have the cooperation renewed for 1937. The contracts in that year covered both the seeding and harvesting of 11,308 acres. The County Soil Conservation Associations agreed to assume the responsibility of executing the contracts with their members, which was a distinct step forward in practical citizenship. As compensation for its work, the Association in turn received a specified percentage of the seed harvested by its farmer members. In the contracts the land was classified in one of four classes, and this classification governed the percentage of the harvested seed which reverted to the Authority.

The harvesting of the 1937 crop of lespedeza occurred, of course, in the fiscal year 1938. Approximately 1,000,000 pounds were harvested, mostly in the Wheeler area, but some from the Guntersville, and Pickwick areas. Of this quantity, the Authority received 252,694 pounds, or approximately one fourth of the total amount. Most of this was used for seeding additional areas in the spring of 1938.

Several benefits have resulted from this program. The reservoir areas have been protected from injury and the reservoirs from silting. The acreage of soil-building lespedeza on farms has increased steadily as a result of efforts by the farmers themselves. The farmers and their associations have developed new abilities in cooperative business and civic responsibility. All parties to the cooperation have shared in the benefits.

## F. IN CONCLUSION

Herein has been presented a statement of the scope and status of a cooperative regional project involving the Land-Grant Colleges of the seven States within which the Tennessee Valley is contained, the United States Department of Agriculture, and the Tennessee Valley Authority. It is believed that, from the experience obtained in carrying forward this cooperative enterprise, a new pattern of coordinated operation is being formulated. This new pattern should enable these agencies, as they further develop their cooperative relationships, to speed up desirable action programs, to economize in the use of public moneys, and to give greater service to the citizens of the area.